IEc

U.S. Virgin Islands: Sustainable Materials Management Analysis

FINAL REPORT March 2021

Prepared for:

U.S. EPA Region 2 on behalf of the US Virgin Islands

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EXECUTIVE SUMMARY

INTRODUCTION

The United States Virgin Islands (USVI) are made of three main islands, St. John, St. Thomas, and St. Croix, with a total land area of 135 square miles. Most waste in the territory is sent for disposal in two landfills that are managed by the Virgin Islands Waste Management Authority (VIWMA). Both landfills are at or near capacity, and have a history of improper disposal practices, surface and subterranean fires, and contaminant leaching problems. Both landfills are under court orders to close, but closure has been delayed due to a need for a waste and materials management alternative to landfilling.

In response to this growing materials management challenge, EPA is assisting the USVI in exploring ways to reduce the quantity of materials managed by landfilling in the USVI by employing sustainable waste management alternatives. To assist the USVI, EPA approached Industrial Economics, Inc. (IEc) to conduct a preliminary study to identify and assess the technical and economic considerations of landfill diversion opportunities potentially available to the USVI, and to identify opportunities for integrated, cross material management approaches. This effort expands on prior EPA technical assistance efforts to document USVI materials management, and incorporates two key sources of data:

- A comprehensive literature search of academic, industry, and news sources that describe USVI conditions and programs, sustainable materials management programs in other regional and island economies, trends in broader materials markets, promising technological innovations, and structural and policy barriers and opportunities with specific relevance to USVI;
- Input from a broad set of regional stakeholders through a series of discussions with USVI waste management officials, local merchants and generators, and sustainable materials management experts.

This study is positioned to be used by the VIWMA as a preliminary investigation into the landscape of possible sustainable materials management approaches for the territory and to inform the development of its Integrated Solid Waste Management Plan. Its purpose is threefold:

1. Characterize the current materials management practices, policies, and challenges across key sectors in the USVI economy;
2. Identify the regional and materials-driven market opportunities and barriers that are most relevant to the challenges identified; and
3. Identify potentially promising landfill diversion and materials management policies and programs to explore further.

Consistent with these objectives, this report documents IEc's findings and details for the following specific topic areas:

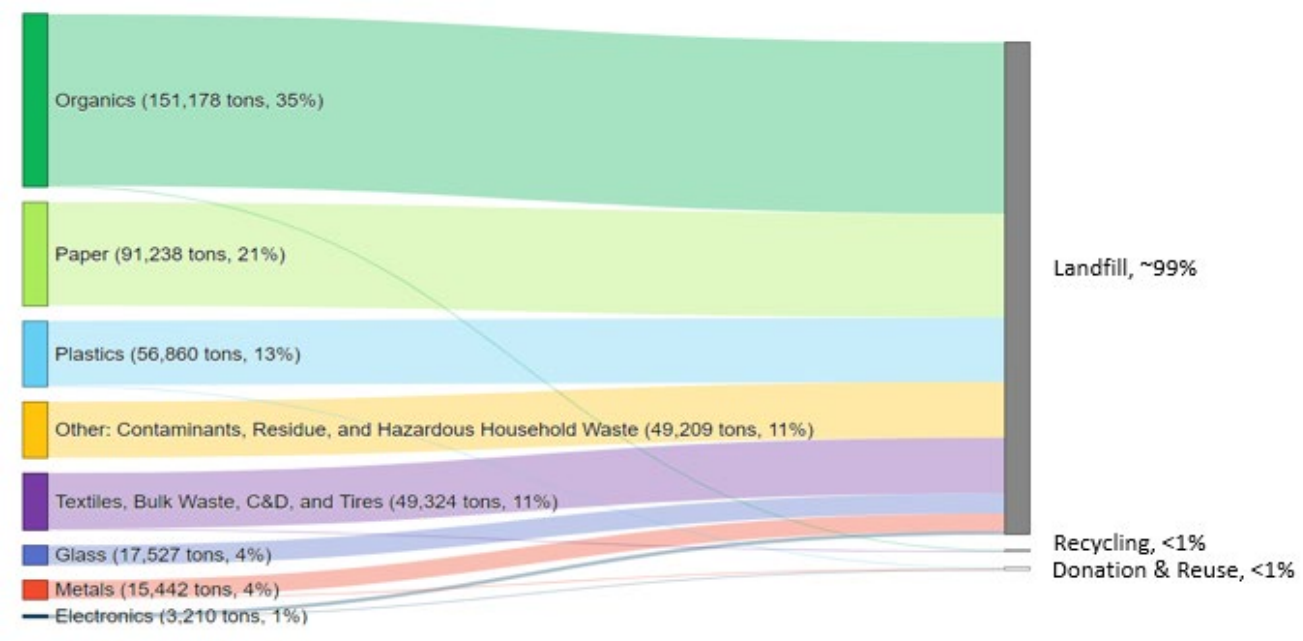
- **Waste Characterization:** Nature and quantity of waste generated and how waste is currently managed in the USVI
- **Economic and Technical Considerations:** Priorities and options for addressing management approaches that have the potential to successfully divert materials from landfills in an island setting
- **Barriers to Implementation:** Structural, behavioral, and market constraints affecting the identified materials management approaches and policy/program options to address such barriers
- **Circular Economy Potential:** Exploration of the possible cross integration of waste streams and materials management approaches to promote a circular economy

These investigations are summarized below and presented in more detail in the following chapters.

CHARACTERIZING WASTE GENERATION AND MATERIALS MANAGEMENT IN THE USVI

To address the mounting waste and materials management issues in the USVI, it is important to first understand the nature and quantity of waste generated, generation sources, and management practices. In total, the USVI generates an estimated 433,989 tons of waste annually from the residential and commercial/industrial sectors, comprised of the following materials and waste types, outlined in Exhibit ES-1.[1] Research indicates that almost all of these materials are landfilled, although there are some small-scale efforts to recycle materials (e.g., metals and electronics) and prevent waste generation through reuse centers and policy (e.g., a territory-wide Plastic Bag Ban and Straw Ban).

EXHIBIT ES-1. SUMMARY OF WASTE MATERIALS FLOWS AND MANAGEMENT IN THE USVI



[1] Based on research from German, Brickner & Bratton Inc., 2009 and The Caribbean Green Technology Center (CGTC), 2020. Note that disaster debris is not included in these estimates. Note that organics include pallets, paper includes corrugated cardboard and other includes contaminants, residue, and hazardous household waste.

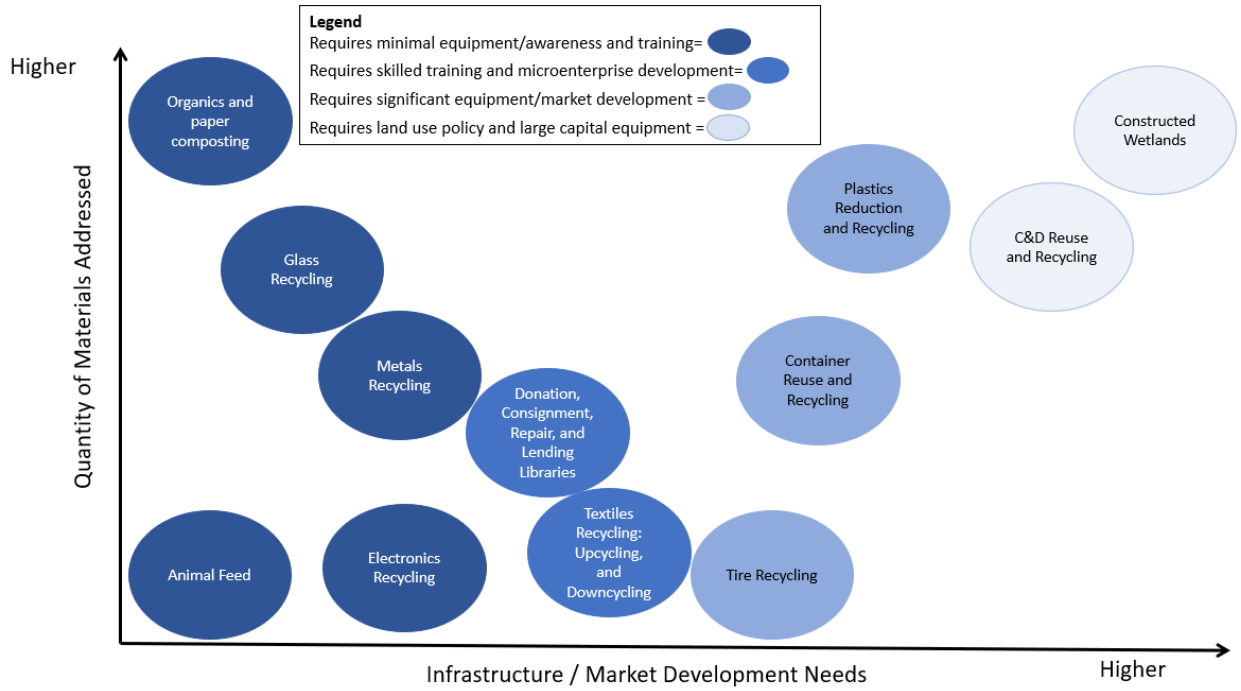
THE POTENTIAL FOR A CIRCULAR ECONOMY IN THE USVI

Research identifies several material management approaches that may be effective at diverting specific materials flows from landfills in the USVI and providing raw materials, and in some cases, finished products, that can serve USVI and other market demands.

The volume of materials affected by each approach varies widely, with organics and paper representing the highest quantities generated. In addition, enabling policies, equipment, and infrastructure differ across materials. For some materials, simple policy solutions and limited investment in equipment can redirect materials into reuse or recycling processes that can meet existing on-island demand. In other cases, more significant investment in training, infrastructure, and equipment is important to effectively align markets.

Exhibit ES-2 arrays the key materials flows, indicating the size of the flow and the level of equipment and training required to enable materials reuse and recovery, and establish effective secondary materials products and markets.

EXHIBIT ES-2. IDENTIFIED MATERIALS MANAGEMENT APPROACHES FOR THE USVI



The successful implementation of one or more of these approaches can help the USVI build momentum toward formation of a "circular economy." In contrast to the "take-make-waste" linear model of production and consumption that currently dominates most economies, a circular economy is based on the principles of "designing out" waste and pollution from the production system, keeping products and materials in use to avoid disposal, and allowing for the regeneration of natural systems. A critical feature of a circular economy is ensuring that materials are consumed and reused until they have reached the end

of their useful life, and then recycled or composted into useful products, replacing the need to use natural resources. Exhibit ES-3 depicts the contrast between the flow of materials in a linear economy with that in a circular economy.

Materials management approaches and policies that divert materials from landfills and support secondary materials uses represent steps toward building a circular economy. This document outlines potential circular economy elements for the USVI organized into the following circular economy stages:

- Material consumption and reuse – to extend product life
- Recycling/composting – to recover materials for use in new products
- Distribution as useful products – to "close the loop" and ensure demand

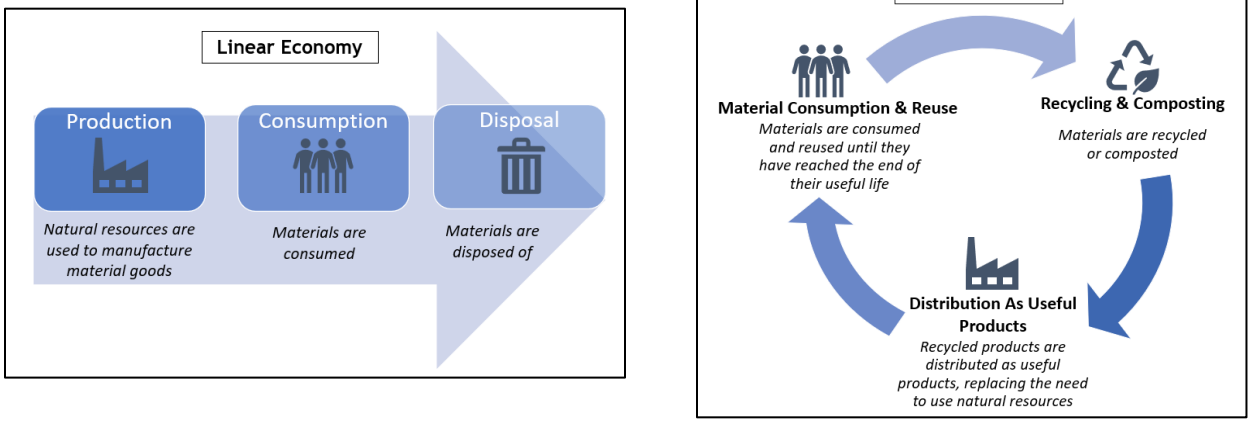
WHAT IS A CIRCULAR ECONOMY?

A circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

Source: Ellen MacArthur Foundation

EXHIBIT ES-3. LINEAR ECONOMY VS CIRCULAR ECONOMY



MATERIAL CONSUMPTION AND REUSE

A functioning circular economy ensures that as products reach their end of life, their materials are reused in the economy through various mechanisms, such as consignment, donation, and repair. These practices, combined with material use prevention programs (e.g., product and packaging bans and waste prevention education programs) aim to move the entire economy away from product disposal.

Focusing on the material management approaches identified as potentially promising for the USVI, material use in a circular economy in the USVI could manifest in the following ways:

- **Elimination of single-use product/packaging waste** (e.g., plastic bags and straws, single-use plastic bottles and food containers) through material bans across the USVI.
- **Recirculation of bulk, electronic, C&D, and textiles** through consignment, donation, repair, and lending libraries to prolong useful life. Existing USVI reuse and consignment facilities (e.g., St. John Eco Station, ReSource Depot, Home Again, Humane Society flea market, Salvation Army

thrift shop, Cece's Closet, Animal Shelter Flea Market, The Women's Coalition Consignment Store, and Uniquities) could expand to include bulk items, repaired electronics, salvaged C&D, and textile goods. In particular, USVI policymakers could leverage the prominence of the tourism industry to partner with establishments, such as hotels, to ensure that usable items are donated. Some establishments (e.g., the Westin) already donate some furniture, and would be willing to expand activities as part of a formal program with local organizations and consignment shops.[2]

- **Recovery and redistribution of consumable excess food** to local communities. Hotels, schools, and restaurants could partner with local community organizations, (e.g., the Reformed Church of St. Thomas, Nana Baby Children's Home, My Brother's Workshop in St. Thomas, Helping Hands Food Pantry in St. John, and My Brother's Table in St. Croix) to distribute food to those in need. A robust donation system with established safety and distribution protocols could connect USVI generators such as the grocer CostULess, which does not currently donate excess food but is interested, to accessing a system to divert food. Organizations such as Nana Baby Children's home have demand for fresh produce, and represent potential demand.[3,4]

Taken together, these waste prevention and reuse efforts could divert roughly 28,823 tons of material from the landfill each year (approximately 6.6 percent of discarded materials currently landfilled) and create demand for around 12 to 24 green jobs in the USVI.

RECYCLING AND COMPOSTING

Once materials reach the end of their useful/repairable life in a circular economy, they are then collected for recycling or composting. Recycling and composting in a circular economy in the USVI could manifest as the following:

- **Generation of compost** by diverting large-volume organics and paper and expanding initiatives such as the Island Green Living composting pilot program, which could serve as a model for eventual composting programs in St. Thomas and St. Croix, as they already have the equipment needed for composting, such as a brush chipper. In addition, to capture large quantities of compostable material with consistent quality, programs could work directly with businesses that generate large volumes of organics, such as hotels, restaurants, and distilling companies (e.g, Leatherback Brewing Company, the Captain Morgan Rum Distillery, Brew STX, and the Cruzan Rum Distillery).
- **Processing of glass discards into secondary materials** such as cullet, ground-glass pozzolan, sand, or for art applications. The USVI could leverage and scale available glass crushing equipment and current glass recycling initiatives on St. Thomas and St. Croix under the oversight of the University of the Virgin Islands. These initiatives can be expanded and serve as a model for an eventual glass recycling program on St. John.

[2] The Westin St. John Resort Villas, phone conversation, 2021.

[3] Nana Baby Children's Home, phone conversation, 2021.

[4] CostULess, phone conversation, 2021.

- **Upcycling and downcycling textiles through micro-enterprises** that could use collected textiles in products such as upcycled clothing and reusable bags. Worn textiles that are unable to be upcycled can be downcycled as rags and blankets for local animal shelters.
- **Micro-enterprise plastic waste collection and recycling**. Collection programs such as The Market Grocery Store Recycling Campaign in St. Thomas and Drop-Off Recycling Group in St. Croix could be expanded to facilitate plastics recycling by on-island microenterprises.
- **Uses for old tires** baled to make retaining walls or recycled as retreaded tires.
- **Deconstruction and recovery of C&D materials** for reuse on-island or sale into secondary markets.
- Wastewater would be sent through **constructed wetlands for treatment**.

While an ideal "localized" USVI circular economy would enable recycling and product markets for every material, the technology requirements and economies of scale for some well-developed secondary markets suggest that defining the circular economy more broadly for those materials would be a stronger approach. This is particularly true of metals and electronics. For example, the USVI would collect electronics and metals for shipment and recycling with regional electronics recyclers (e.g., Piranha International Limited in Trinidad and Tobago, or DRE Repair Services in the Dominican Republic) and nearby metals recyclers (e.g., Borniquen Metal Scrap, Homeca Recycling Center, Caribbean Recycling Group Inc. in Puerto Rico). The USVI could also look to partner with shipping companies to save costs on recycling. A representative from Tropical Shipping Company indicated that their company offers preferred shipping rates for certain commodities, and they would be willing to work with the VIWMA to negotiate a discounted price for shipping recyclable materials.[5]

Together these reduction opportunities represent diversion of around 355,870 tons of material from the landfill annually (approximately 82 percent of discarded materials currently landfilled) and creation of around 130 green jobs.

DISTRIBUTION AS USEFUL PRODUCTS

Once materials are collected and recycled/combusted, a circular economy includes demand for the resulting products. On-island production and distribution of products in a circular economy in the USVI could manifest as:

- **Locally-sourced high-volume construction materials,** saving both landfill space and reducing the cost of acquiring high-volume virgin materials such as gravel, sand, and other aggregate. Recycled C&D products such as concrete, asphalt, and wood could be used as: a gravel substitute for walkways and driveways; road construction fill and base; erosion control, shore armoring, or coral reef foundations; or a substitute for virgin aggregate in concrete, asphalt, and brick manufacturing or combined with glass recycled as ground-glass pozzolan. C&D materials could also be combined with recycled glass as cullet or glass mulch and used as fill or for landscaping. Construction companies (e.g., PSI Tire Supply LLC in St. Croix, Concrete VI in St. Croix, Spartan Concrete

[5] Tropical Shipping Company, phone conversation, 2021.

Products, LLC in St. Croix, and Heavy Materials LLC in St. Thomas) would purchase recycled C&D products to replace virgin materials in construction materials processing.

- **A sustainable substitute for sand.** Recycled glass as silica has many uses such as golf courses (e.g., Buccaneer Golf Course, Mahogany Run Golf Course, Carambola Golf Club, Reef Club Golf Course), assuming the sand meets the Professional Golf Association's certification standards, and beaches to replace importation of sand. The VIWMA would also purchase the sand for constructed wetlands for natural wastewater treatment.
- **Raw materials for artists and other microenterprises.** Recycled glass might have demand among local craftspeople, and collected plastics from on-island microenterprises would be recycled and formed into furniture, fencing, docks, art, jewelry, and other lifestyle products. Facilitating plastic recycling microenterprises would support small businesses in the USVI while also reducing the need to import certain plastic products. Upcycled textiles as reusable bags would be sold by micro-enterprises to those seeking reusable bags to comply with the plastic bag ban. Downcycled textiles as rags and blankets would be donated to local pet shelters.
- **Soil enhancements for agriculture.** Composted organics and paper could be sold to enhance soil or for engineering purposes such as erosion control. With a total of 9,324 acres, local farms (e.g., Ride to Reef Farm, Hideaway Farm, Sejah Farm of the Virgin Islands) would purchase the compost to offset importation of fertilizer and improve crop yields. Landscaping companies (e.g., LaPlace Landscaping and Maintenance, Island Designs Landscape & Storm Water Solutions LLC, and Cruzan Garden) would purchase the compost to offset importation of soil and fill. Organics, such as spent grains from breweries, would be collected and distributed as animal feed. Should food manufacturing companies become established in the USVI, spent grain can also be delivered to food manufacturing companies to be incorporated into spent grain baked goods. Conversations with breweries, such as Brew STX, noted that they already informally donate their spent grains to farms and would be willing to do so under a formal program.
- **Recycled tires** in the form of retaining walls would be used as structures to divide areas at composting and landfilling facilities to facilitate the separating of materials for recycling collection/composting.

ENABLING POLICIES AND PROGRAMS

Policies and programs can be used to enable the formation of a circular economy in the USVI. Enabling policies and programs to support material consumption and reuse would include product and packaging bans, as well as educational campaigns to promote reuse, borrowing/lending, and repair. More intensive subsidized workshops on repair would help establish and expand microenterprises focused on supplying local demand. Financial support, such as loans, for interested parties could help to develop microenterprises. More broadly, reuse markets and behaviors would benefit from educational campaigns focused on how to donate food in compliance with USVI food and health standards, and tourism education on territory-wide materials management approaches; these efforts could motivate and encourage a robust culture of waste prevention in USVI's circular economy.

To enable recycling and composting, USVI policymakers could explore the implementation of supporting policies and programs for materials recovery, some of which would require equipment and infrastructure investment. These policies and programs include, but are not limited to, a territory-wide zero waste goal

and tracking, landfill tipping fees and/or or pay-as-you-throw fees, ordinances requiring recycling and source separation, collection programs, material (e.g., organics, C&D, electronic waste, and tires) landfill bans, recycling container distribution and recycling collection, and zero waste parks. Technical training on recycling and recovery techniques, such as composting, could also ensure interested parties are trained in the proper techniques for successful implementation. These policies and programs would help to shift incentives away from disposal and toward recycling, composting, and new products.

To enable the distribution of recycling products and commodities as useful products, policies geared towards sustaining and integrating markets could be implemented. Such policies include, but are not limited to a container deposit program, green purchasing requirements, product labeling requirements, transparent advanced disposal fees, extended producer responsibility, green infrastructure requirements, green business certification programs, and green building certification programs. These policies and programs could help spur demand for recycled products and ultimately lead to motivating and encouraging a robust market for recycling and recycled products in the USVI's circular economy.

By implementing landfill diverting and materials management approaches and policies/programs, the USVI can take steps to build a circular economy. A circular economy in the USVI has the potential to expand on existing donation and recycling/composting initiatives in the territory as well as encourage and involve the participation of multiple market actors. Exhibit ES-5 summarizes the materials management approaches, programs, and policies that would support the formation of a circular economy, arranged by circular economy stage and the level of near- and longer-term investment required.

RECOMMENDATIONS

The process of establishing a vibrant circular economy in the USVI requires attention to the specific technical and economic considerations surrounding specific USVI materials markets. It is critical that projects consider the land, equipment, and resilience requirements to cost-effectively operate within the territory, and that enabling policies effectively address the behavioral, infrastructure, knowledge, and market barriers to successful implementation. Reflecting these priorities, the following recommendations outline a series of initial steps that can move the USVI toward an integrated circular economy.

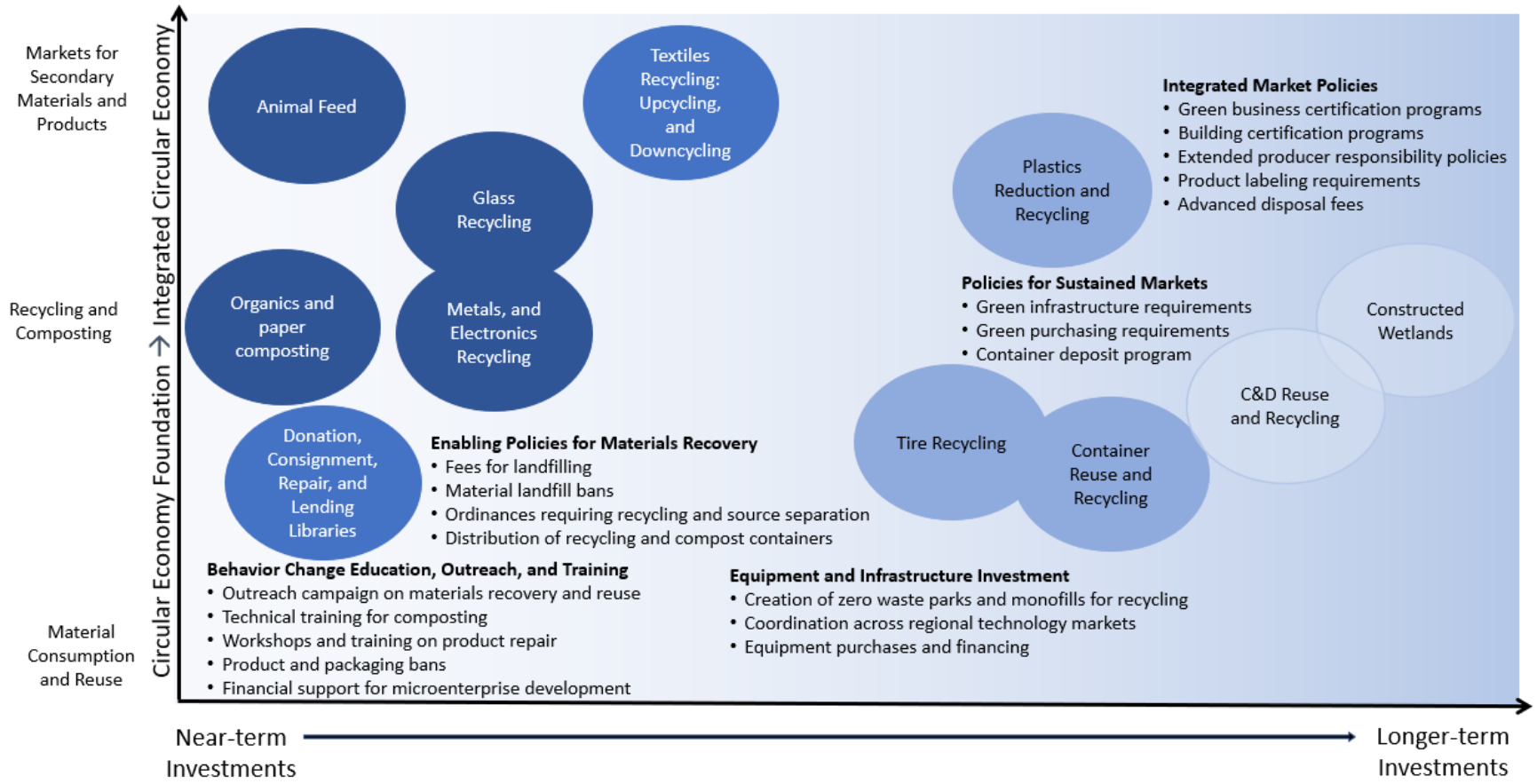
STRATEGIC DIRECTION: IDENTIFY AND PRIORITIZE MATERIALS MANAGEMENT APPROACHES

Because a circular economy by definition involves intersecting activities and markets, it is important to develop a strategic approach that leverages existing resources and momentum within the USVI and also addresses key barriers and challenges. This approach involves three recommended steps:

Identify Priority Materials and Management Approaches

An initial step in this process is prioritizing the materials and management approaches that can be most readily addressed. In establishing priorities, USVI policymakers might consider the materials attributes identified in this report, such as material volume, existing infrastructure, and existing secondary materials markets. Other considerations such as safety, existing partnerships, and visibility/interest to the public may factor into initial decision.

EXHIBIT ES-5. INTEGRATED CIRCULAR ECONOMY TIMELINE FOR MATERIALS MANAGEMENT AND PROGRAM/POLICY APPROACHES



Conduct Technical and Economic Feasibility Assessment for Prioritized Materials

For materials and management approaches determined to be of serious interest, it is recommended the USVI conduct a focused technical and economic assessment, bringing in appropriate expertise (e.g., engineers and market experts) to identify feasible locations in the USVI, identify needed capital investments, training, operating costs, and financing/funding needs arrangements, and evaluate community impacts such as local employment and resource needs (e.g., food insecurity) that might be addressed. The assessment would likely also identify potential barriers to successful implementation and identify policies and programs to address such barriers and ensure success.

In their study, it is recommended the USVI consider the impact of existing and soon-to-be policies. For instance, implementation of a robust excess food donation program may decrease the quantity of discarded food generated, affecting the scale of future composting operations.

While the final priorities must reflect local experts and conditions, this study has identified a set of materials management approaches with possible near-term applicability and impact:

- **Organics and paper composting:** This effort is high volume, addressing 242,417 tons (56 percent) of discarded materials generated in the USVI, requires only modest equipment investment and limited technology, and can build on existing composting efforts in the USVI, such as the Island Green Living composting pilot program. Further, farms and landscapers represent a potential market for compost. Our research indicates that market actors in the USVI are already familiar with the benefits and applications for composting as several farms and breweries are already composting their vegetative residue.
    - In addition to composting, some organic materials, such as spent grain, can be diverted as **animal feed**. Again, this effort would require limited infrastructure or technology investment, and is already in practice in the USVI; several breweries already send their spent grains to local farms as animal feed for chickens and pigs. A formal system to promote sustainable partnerships between generators of animal feed-grade excess food (e.g., breweries) and farms might increase this practice without significant investment.
- **Donation/consignment/repair/lending libraries** could address around 28,823 tons (6.6 percent) of discarded materials generated in the USVI, and could leverage the existing network of donation and consignment facilities in the territory that work with a number of donors. Investment would include a focus on logistics more than technology or capital equipment. A more formal system, however, could facilitate and promote partnerships between reuse facilities and hotels and schools, which typically generate material suitable for resale and reuse (e.g., furniture). For excess food, the USVI could explore creating a formal system to promote food donation between restaurants and stores and local food pantries.
- **Textile upcycling downcycling** has the potential to divert around 11,981 tons (three percent) of materials from the landfill. The USVI could explore market-development for these materials, such as local artists and product designers of both high-end products with re-sale value, such as reusable bags, and downcycled uses as rags and animal bedding.

- **Glass recycling** has the potential to divert around 17,527 tons (four percent) of materials from the landfill. While this approach requires more capital investment, the University of the Virgin Islands recently secured the purchase of give glass crushers for St. Thomas and St. Croix with funding from the Community Foundation of the Virgin Islands and the Ocean Conservancy. These organizations are planning on collecting and recycling glass into glass cullet and sand for landscaping purposes and to make sandbags for hurricane preparation. While these operations have not yet commenced, the USVI could explore partnering with these initiatives to expand glass recycling in the territory.
- **Metals recycling** has the potential to divert around 15,442 tons (3.6 percent) of materials from the landfill. Metals in the USVI is already collected, baled, and shipped off-island by recycling companies in the USVI, such as the VI Recycling Company and Mendez Recycling, and several volunteer-run operations, such as recycling initiatives led by The Market grocery stores. The USVI could explore partnering with these organizations as they already have the initial equipment needed for recycling (e.g., can crushers and balers) and possibly contract with metal recyclers close to the USVI (e.g., Borniquen Metal Scrap, Procesadora De Metales LLC, Homeca Recycling Center, and Caribbean Recycling Group, Inc.)
- **Electronics recycling** has the potential to divert around 3,210 tons (one percent) of materials from the landfill. Most electronics in the USVI is already collected by the VIWMA and shipped to a certified recycler, ITAD Tech in Peachtree Corners, GA. To the extent that donation and repair efforts outlined above include electronics reuse and repair, the quantity of electronics requiring recycling could decrease. In addition, the VIWMA could consider exploring contracts with closer, certified recyclers, such as Piranha International Limited in Trinidad and Tobago, or DRE Repair Services in the Dominican Republic, which in addition to offering recycling services, hosts a buy-back program on certain electronics such as mobile phones.

Identify and Align Enabling Policies

In tandem with the assessment of priority materials and management approaches, the USVI could explore the programs and policies that would address the existing behavioral, infrastructural, knowledge, and market barriers to implementation. These programs and policies range from broad public awareness campaigns and education efforts, to more targeted skills training, to policies that incentivize alternative approaches to landfilling.

Enabling programs and policies are critical to providing the foundation for robust market for sustainable materials management. Exhibits ES-2 and ES-5 above provide an overview of the promising materials management options and related policies and programs identified in this report, aligned with the stages of sustainable materials management market development and with the likely implementation time and resources needed to establish markets of different technical complexity. Materials management approaches shaded in dark represent nearer-term areas of focus due, reflecting existing infrastructure and ready markets in the USVI, and limited need for capital investment. Lighter blue shading indicates limited markets on island (a need to consider regional markets) or more significant capital investment and policy alignment.

INITIAL IMPLEMENTATION: PROVIDE A ROBUST TRAINING AND TRACKING PROGRAM

A critical aspect of a circular economy is creating a culture and an economy that recognizes the value of materials in different stages, and is poised to recover, reuse, and produce goods that the economy needs. Therefore, an initial step in any implementation is effective public education and technical training. Concurrent with this, it is important to track the materials that move in the economy to ensure that policies and markets are functioning well as they become established.

Therefore, once the USVI has prioritized materials management approaches and accompanying policies/programs, the territory should institute a robust materials diversion training and tracking program. One format for this might build on the experience of Zero Waste communities (e.g., in the Philippines) to provide training for residents and businesses on source separation for target materials. Similarly, haulers and materials managers (e.g., landfill employees) could be trained to manage source-separated materials to prevent contamination and coordinate with or operate material management processing facilities (e.g., glass collected for recycling is not co-mingled with metals and is sent to the appropriate glass recyclers).

To support enabling policies, in particular material bans such as plastics bans, it will be important to notify and work with facilities such as hotels, restaurants, and retail establishments, as well as groups including residents and tourists, to ensure sufficient awareness of bans and on material alternatives (e.g., reusable bags, reusable food containers, reusable water bottles, etc.) and compliance with policy.

Materials management approaches that require more technical expertise, such as repair and composting, represent an investment in technical education and micro-enterprise. Publicly available free or subsidized workshops/webinars and business assistance in sourcing and operating facilities could enable residents and businesses to become more familiar with and positive about composting on their available land and repairing items on their own.

In line with a robust training effort, it is important to develop a transparent measurement program to track the progress of materials management by material type and management practice. EPA's guidance for state and local governments for MSW can serve as a helpful resource as this has served as a cornerstone of Guam's successful Zero Waste program.[6, 7] Annual reporting, by material type, could be mandatory for recyclers, composters, and landfills. In addition, USVI could explore reviewing import and export and other data sources that could provide additional metrics to consistently track results.

REGIONAL AND SUSTAINABLE CIRCULAR ECONOMY: DEVELOP PARTERNSHIPS WITHIN AND OUTSIDE THE USVI

While the central focus of this report is on opportunities for establishing a circular economy within the USVI, some materials markets and recovery technologies are both well-established and capital-intensive (e.g., metals recovery). In addressing these materials, an expanded regional economy may be the most effective approach.

[6] More information available here: https://archive.epa.gov/wastes/conserve/tools/recmeas/web/html/download.html

[7] Guam Environmental Protection Agency, 2014.

Therefore, to understand both the USVI-specific issues that affect recovery and recycling of materials, and to help expand materials management efforts in the broader region, the USVI should work to develop partnerships at two levels:

- Primary partnerships with organizations within the territory to provide momentum for establishing a USVI circular economy. On example is the Island Green Living Association that is piloting reuse, recycling, and composting programs.
- Strong regional partnerships with organizations and governments outside the USVI with established recovery and recycling programs and Zero Waste programs. Examples include the Bermuda Ministry of Public Works, the British Virgin Island's WeRecycle program, the Hawaiian Islands, and Guam. These programs can likely offer insight and advice on best practices for instituting a culture of and programs addressing reuse and recovery in an island setting, and, notably, for establishing or accessing existing markets for specific materials that reach beyond the USVI.

One model for these partnerships could be a standing stakeholder group comprised of various industries, residents, and government officials within and outside the USVI, and potentially across the broader surrounding area for materials markets that are more regional. By working to bring about an evolution in public policy, such as implementing landfill tipping fees and green procurement policies, the government can steer the USVI economy toward a circular future.

In the same vein, whether the circular economy will work depends largely on consumers. Residents and business would need to change their behavior and purchase and use products with reuse and recyclability in mind. Creating a stakeholder group can help to identify the integration of policy and materials management opportunities within the USVI. A helpful starting point would be to invite the possible circular economy market actors identified in Chapter 4 of this report and work with organizations, such as ReCaribe, to revive efforts to bring together islands in the Caribbean to create economies of scale to recover waste.

CHAPTER 1 | CHARACTERIZING WASTE GENERATION AND MATERIALS MANAGEMENT IN THE USVI

The United States Virgin Islands (USVI) are made of three main islands, St. John, St. Thomas, and St. Croix, with a total land area of 135 square miles. Most waste in the territory is sent for disposal in two landfills that are managed by the Virgin Islands Waste Management Authority (VIWMA). Both landfills are at or near capacity, and have a history of improper disposal practices, surface and subterranean fires, and contaminant leaching problems. Both landfills are under court orders to close, but closure has been delayed due to a need for a waste and materials management alternative to landfilling.

To address the mounting materials management concerns in the USVI and identify a solution to its closing landfills, it is important to first understand the nature and quantity of discarded materials generated, generation sources, and management practices. This chapter focuses on characterizing the nature of waste generation in the USVI, then details the facilities and industries generating discards, and finally discusses the systems in place to manage discarded materials.

CHARACTERIZATION OF WASTE

Discarded materials in the USVI is generated by the two broad sectors that form the economy: residential and commercial/industrial. To determine the nature of discarded material generation among the residential sector, IEc relied on the results of a 2019 study conducted by The Caribbean Green Technology Center at the University of the Virgin Islands and Resource Recycling Systems, in partnership with U.S. EPA Region 2.[8] The research team conducted a five-day residential waste characterization by sorting and weighing all material found in randomly selected samples of residential material disposed of at the USVI landfills. The team then used the results to extrapolate the quantity of materials discarded annually by USVI residents.

To determine the nature of waste generation among the commercial/industrial sector, IEc referenced a 2009 waste characterization study commissioned by the VIWMA and aligned the results of that with the 2019 residential waste characterization study as a more recent waste characterization report for the commercial/industrial sector was not readily available.[9] Specially, IEc assumed that the proportion of commercial/industrial to residential waste was the same in 2019 as in 2009 and applied that proportion to the total 2019 residential waste figure to arrive at the total quantity of waste generated by the commercial/industrial sector in 2019. We then applied the percentage waste composition noted in the 2009 waste characterization report for the commercial/industrial waste stream to the estimated 2019

[8] The Caribbean Green Technology Center (CGTC), 2020.

[9] Gershman, Brickner & Bratton, Inc., 2009.

commercial/industrial waste generation figure to arrive at the breakdown of materials discarded by the commercial/industrial sector for 2019.

Exhibit 1-1, 1-2, and 1-3 below details the annual quantity of materials discarded, broken down by material type and island. [10] As shown in the tables, St. Thomas discards the most material annually (271,428 tons), followed by St. Croix (140,616 tons), then St. John (21,946 tons). In addition to the materials detailed below, the VIWMA estimates that 1.6 billion gallons of wastewater is treated by the territory's wastewater treatment plants annually.[11]

EXISTING FACILITIES GENERATING DISCARDS

Discarded materials on the USVI is generated by a few different sectors and facilities. This section describes the various entities responsible for waste production in the USVI.

RESIDENTIAL POPULATION

The waste characterization results indicate that the residential population is responsible for generating 40 percent of the waste in the territory, the nature of which is general MSW with organics (e.g., food, yard waste, etc.), paper (e.g., corrugated cardboard, newsprint, etc.), and plastic accounting for approximately 62 percent of the total residential waste stream.

The USVI has a total population of just over 104,000, predominantly located on the islands of St. Thomas and St. Croix.[12] The territory's roughly 44,000 households are split approximately evenly between renters and homeowners. Exhibit 1-4 details the breakdown of the residential population across the islands. While the most recent census information is from 2010, more recent estimates place the island's total population constant at just over 100,000.

EXHIBIT 1-4. RESIDENTIAL ENTITIES IN THE USVI

	ST. JOHN	ST. THOMAS	ST. CROIX	USVI TOTAL
Population	4,170	51,634	50,601	**106,405**
Households	1,734	21,473	21,043	**44,250**
Owner Households	817	10,118	9,915	**20,850**
Renter Households	917	11,355	11,128	**23,400**

Note: Island-specific household estimates are calculated based on island population share.
Source: U.S. Census Bureau, 2010.

[10] Note that these waste figures reflect waste generation pre-COVID 19 pandemic. Although tourism has decreased since the pandemic, the VIWMA officials expect that the volume of waste will largely return to the levels they were before COVID-19. In addition, estimates of disaster debris are not included in these figures.

[11] Virgin Islands Waste Management Authority, 2020.

[12] United Nations World Population Division, 2019.

EXHIBIT 1-1. 2019 WASTE CHARACTERIZATION OF ST. THOMAS, BROKEN DOWN BY WASTE TYPE

GENERAL CATEGORY	SPECIFIC CATEGORY	RESIDENTIAL WASTE GENERATION (TONS)	% OF RESIDENTIAL WASTE	COMMERCIAL/INDUSTRIAL WASTE GENERATION (TONS)	% OF COMMERCIAL/ INDUSTRIAL WASTE	TOTAL QUANTITY OF WASTE (TONS)
Metals	Cans	1,266	1.5%	525	0.3%	1,791
	Other Aluminum	84	0.1%	-	0.0%	84
	Foil	760	0.9%	-	0.0%	760
	Other Ferrous	2,448	2.9%	657	0.4%	3,105
	Tin Cans	1,520	1.8%	2,103	1.1%	3,622
Glass	Brown	1,266	1.5%	1,360	0.7%	2,627
	Clear	2,533	3.0%	1,629	0.9%	4,162
	Mixed	1,689	2.0%	653	0.3%	2,341
	Other Glass	-	0.0%	-	0.0%	-
Organics	Food Waste	13,256	15.7%	31,931	17.1%	45,187
	Lumber (includes pallets)	6,839	8.1%	21,478	11.5%	28,317
	Other Organics	84	0.1%	-	0.0%	84
	Wood/Bush	6,754	8.0%	18,838	10.1%	25,592
Other	Bulk Waste	760	0.9%	5,267	2.8%	6,027
	C&D	3,124	3.7%	16,471	8.8%	19,595
	Contaminants (e.g., feces)	-	0.0%	17,179	9.2%	17,179
	Electronics	507	0.6%	2,175	1.2%	2,682
	HHW	169	0.2%	-	0.0%	169
	Liquids	-	0.0%	-	0.0%	-
	Residue	5,488	6.5%	1,113	0.6%	6,601
	Small Appliances	338	0.4%	-	0.0%	338
	Textiles	2,871	3.4%	2,004	1.1%	4,875
	Tires	169	0.2%	-	0.0%	169
Paper	Aseptic	760	0.9%	3,838	2.1%	4,598
	Corrugated	7,345	8.7%	33,287	17.8%	40,633
	Mixed Paper	4,813	5.7%	1,531	0.8%	6,344
	Newsprint	675	0.8%	1,190	0.6%	1,865
	Office Paper	1,182	1.4%	1,727	0.9%	2,909
Plastic	Bulky Rigids	760	0.9%	559	0.3%	1,319
	Colored HDPE Bottles	1,604	1.9%	934	0.5%	2,538
	EPS	1,604	1.9%	631	0.3%	2,235
	Film	4,897	5.8%	4,546	2.4%	9,443
	HDPE Non-Bottle (e.g., toys and containers)	84	0.1%	10,492	5.6%	10,576
	Mixed Rigids	2,617	3.1%	-	0.0%	2,617
	Natural HDPE Bottles	1,857	2.2%	943	0.5%	2,800
	PET Bottles	3,799	4.5%	2,704	1.4%	6,503
	PET Non-Bottle	422	0.5%	1,318	0.7%	1,740
Total		**84,346**	**100%**	**187,082**	**100%**	**271,428**

EXHIBIT 1-2. 2019 WASTE CHARACTERIZATION OF ST. JOHN, BROKEN DOWN BY WASTE TYPE

GENERAL CATEGORY	SPECIFIC CATEGORY	RESIDENTIAL WASTE GENERATION (TONS)	% OF RESIDENTIAL WASTE	COMMERCIAL/INDUSTRIAL WASTE GENERATION (TONS)	% OF COMMERCIAL/INDUSTRIAL WASTE	TOTAL QUANTITY OF WASTE (TONS)
Metals	Cans	75	1.1%	42	0.3%	117
	Other Aluminum	27	0.4%	-	0.0%	27
	Foil	-	0.0%	-	0.0%	-
	Other Ferrous	143	2.1%	53	0.4%	196
	Tin Cans	41	0.6%	170	1.1%	211
Glass	Brown	123	1.8%	110	0.7%	233
	Clear	184	2.7%	132	0.9%	316
	Mixed	130	1.9%	53	0.3%	182
	Other Glass	34	0.5%	-	0.0%	34
Organics	Food Waste	593	8.7%	2,579	17.1%	3,173
	Lumber (includes pallets)	1,432	21.0%	1,735	11.5%	3,167
	Other Organics	143	2.1%	-	0.0%	143
	Wood/Bush	20	0.3%	1,522	10.1%	1,542
Other	Bulk Waste	211	3.1%	425	2.8%	637
	C&D	587	8.6%	1,330	8.8%	1,917
	Contaminants (e.g., feces)	1,023	15.0%	1,388	9.2%	2,411
	Electronics	34	0.5%	176	1.2%	210
	HHW	-	0.0%	-	0.0%	-
	Liquids	143	2.1%	-	0.0%	143
	Residue	20	0.3%	90	0.6%	110
	Small Appliances	123	1.8%	-	0.0%	123
	Textiles	123	1.8%	162	1.1%	285
	Tires	41	0.6%	-	0.0%	41
Paper	Aseptic	14	0.2%	310	2.1%	324
	Corrugated	941	13.8%	2,689	17.8%	3,630
	Mixed Paper	89	1.3%	124	0.8%	212
	Newsprint	41	0.6%	96	0.6%	137
	Office Paper	14	0.2%	140	0.9%	153
Plastic	Bulky Rigids	41	0.6%	45	0.3%	86
	Colored HDPE Bottles	34	0.5%	75	0.5%	110
	EPS	14	0.2%	51	0.3%	65
	Film	164	2.4%	367	2.4%	531
	HDPE Non-Bottle (e.g., toys and containers)	14	0.2%	847	5.6%	861
	Mixed Rigids	75	1.1%	-	0.0%	75
	Natural HDPE Bottles	48	0.7%	76	0.5%	124
	PET Bottles	82	1.2%	218	1.4%	300
	PET Non-Bottle	14	0.2%	106	0.7%	120
Total		**6,834**	**100%**	**15,112**	**100%**	**21,946**

Note: St. John waste is also landfilled at Bovoni Landfill in St. Thomas, but its commercial composition is unknown so the composition for the waste at St. John was assumed to be the same as St. Thomas.

EXHIBIT 1-3. 2019 WASTE CHARACTERIZATION OF ST. CROIX, BROKEN DOWN BY WASTE TYPE

GENERAL CATEGORY	SPECIFIC CATEGORY	RESIDENTIAL WASTE GENERATION (TONS)	% OF RESIDENTIAL WASTE	COMMERCIAL/INDUSTRIAL WASTE GENERATION (TONS)	% OF COMMERCIAL/INDUSTRIAL WASTE	TOTAL QUANTITY OF WASTE (TONS)
Metals	Cans	331	0.4%	138	0.2%	469
	Other Aluminum	414	0.5%	-	0.0%	414
	Foil	-	0.0%	-	0.0%	0
	Other Ferrous	1,820	2.2%	887	1.5%	2,707
	Tin Cans	827	1.0%	1,110	1.9%	1,938
Glass	Brown	1,076	1.3%	519	0.9%	1,595
	Clear	2,648	3.2%	789	1.4%	3,437
	Mixed	1,820	2.2%	449	0.8%	2,269
	Other Glass	331	0.4%	-	0.0%	331
Organics	Food Waste	1,572	1.9%	5,717	9.9%	7,289
	Lumber (includes pallets)	3,972	4.8%	6,399	11.1%	10,370
	Other Organics	1,986	2.4%	-	0.0%	1986
	Wood/Bush	11,749	14.2%	12,579	21.7%	24,328
Other	Bulk Waste	2,730	3.3%	3,640	6.3%	6,370
	C&D	-	0.0%	1,955	3.4%	1,955
	Contaminants (e.g., feces)	17,127	20.7%	2,808	4.9%	19,935
	Electronics	165	0.2%	153	0.3%	318
	HHW	331	0.4%	-	0.0%	331
	Liquids	248	0.3%	-	0.0%	248
	Residue	1,820	2.2%	262	0.5%	2,082
	Small Appliances	-	0.0%	138	0.2%	138
	Textiles	6,206	7.5%	616	1.1%	6,821
	Tires	-	0.0%	34	0.1%	34
Paper	Aseptic	827	1.0%	1,138	2.0%	1,965
	Corrugated	11,004	13.3%	11,371	19.6%	22,375
	Mixed Paper	2,234	2.7%	632	1.1%	2,866
	Newsprint	2,069	2.5%	56	0.1%	2,125
	Office Paper	662	0.8%	439	0.8%	1,101
Plastic	Bulky Rigids	1,407	1.7%	296	0.5%	1,703
	Colored HDPE Bottles	579	0.7%	269	0.5%	848
	EPS	662	0.8%	723	1.2%	1,385
	Film	2,565	3.1%	1,598	2.8%	4,163
	HDPE Non-Bottle (e.g., toys and containers)	331	0.4%	255	0.4%	586
	Mixed Rigids	1,158	1.4%	-	0.0%	1,158
	Natural HDPE Bottles	414	0.5%	123	0.2%	536
	PET Bottles	993	1.2%	561	1.0%	1,554
	PET Non-Bottle	662	0.8%	2,222	3.8%	2,884
Total		**82,740**	**100%**	**57,876**	**100%**	**140,616**

COMMERCIAL/INDUSTRIAL

Within the commercial/industrial sector, the primary economic driver is tourism, with over 2.5 million people visiting the USVI each year and the tourism industry accounting for 54 percent of total GDP in the territory in 2017.[13, 14] The majority of tourists are cruise passengers visiting for short periods of time, though the islands also see over 750,000 annual visitors via air travel, resulting in longer stays at hotels. The majority of tourism activity takes place on St. Thomas and St. John. Exhibit 1-5 outlines tourist visits by travel mode and the location of associated lodging facilities across the islands.

EXHIBIT 1-5. TOURISM – U.S. VIRGIN ISLANDS

	ST. JOHN/ST. THOMAS	ST. CROIX	USVI TOTAL
Cruise passengers	1,747,600	110,200	**1,857,800**
Number of cruise ships	560	58	**618**
Air visitors	622,700	141,400	**764,100**
Number of hotels	27	14	**41**
Hotel rooms	2,979	925	**3,904**
Condominium/other units	865	293	**1,158**

The waste characterization results indicate that the commercial/industrial sector is responsible for generating 60 percent of the discarded materials in the territory. Much like the residential sector, the nature of this waste is general MSW with organics (e.g., food, yard waste, etc.), paper (e.g., corrugated cardboard, newsprint, etc.), and plastic accounting for the majority of the waste stream (74 percent). The composition of the commercial/industrial sector discarded materials stream aligns with discarded materials streams commonly generated by tourists.

The USVI also supports retail and industrial sectors, not all of which is directly related to the tourism sector. These sectors generate general MSW as well as other material types. Specific large entity categories and the types of materials discarded include the following:

- **Refinery:** Temporarily shuttered in the early 2000s, the Limetree Bay Oil Refinery resumed operation in late 2019. This facility is the largest single refinery in the western hemisphere. While its employment fluctuates due to operational demand, it typically employs between 2,500 and 4,500 people. This facility generates general MSW (e.g., food, paper, etc.) from typical office operations, along with non-hazardous and hazardous waste associated with refining operations.[15]
- **Medical Centers:** The Juan F. Luis Medical Center on St. Croix and the Schneider Regional Medical Center on St. Thomas each employ upwards of 500 people. These facilities generate

[13] U.S. Virgin Islands Bureau of Economic Research, 2020.

[14] United States Virgin Islands Economic Development Authority.

[15] In 2017, the most recent year for which information is available, the Limetree Bay Oil Refinery generated 2,597 tons of waste, most of which was shipped off-island. The nature of this waste includes: ignitable waste, corrosive waste, reactive waste, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, benzene, and methyl ethyl ketone. Source: U.S. Environmental Protection Agency, 2017b.

general MSW (e.g., food, plastic, etc.) from general office operations and patient care, along with medical waste.

- **Breweries:** In recent decades, a number of breweries and distilleries have opened in the territory, primarily on St. Croix. These include the Leatherback Brewing Company, the Captain Morgan Rum Distillery, Brew STX, and the Cruzan Rum Distillery. These facilities generate compostable and animal feed-grade materials associated with brewing and distilling activities, such as spent grains, spent yeast, and other materials such as, packaging materials.
- **Construction:** Construction companies, such as J. Benton Construction in St. Croix, Cutting Edge Construction in St. John, and PSI Tire Supply LLC, a conglomerate of construction and contracting operations working throughout the territory, primarily generate C&D related materials (e.g., concrete, lumber, brick, etc.), which is all brought to the landfill.
- **Retail:** Over 400 retail shops exist in the territory, ranging from small businesses selling locally produced goods to big label retailers. St. Thomas's "Little Switzerland" shopping zone is renowned for watchmaker retailers, and a number of small locally owned entities produce crafts, soaps, metalwork, and other art. These facilities generate general MSW (e.g., paper metal, plastic, etc.). Big box retailers, such as Home Depot and CostULess, also generate general MSW, particularly cardboard and wooden pallets in large quantities.

Exhibit 1-6 details the number of commercial and industrial entities by North American Industrial Classification System (NAICS) coding, as well as the associated employment.

EXHIBIT 1-6. GENERAL INDUSTRY DATA FOR THE USVI

INDUSTRY	DESCRIPTION	NUMBER OF ENTITIES BY EMPLOYMENT								
		1-5	5-9	10-19	20-49	50-99	100-249	250+	Size Not Reported	TOTAL
Retail trade	Store and non-store retailing, services related to sales	232	104	61	28	8	9	0	4	446
Accommodation and food services	Lodging and/or preparing meals, snacks, and beverages for immediate consumption.	114	55	63	40	9	0	0	4	285
Professional, scientific, and technical services	Legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.	159	42	21	3	0	0	0	4	229
Other services (except public administration)	Equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services	153	45	15	7	0	0	0	3	223
Health care and social assistance	Establishments providing health care and social assistance for individuals	119	46	24	20	3	0	0	4	216
Real estate and rental and leasing	Renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services.	127	33	20	4	0	0	0	3	187
Construction	Building construction and engineering projects	97	24	27	14	0	0	0	8	170
Administrative and support and waste management and remediation services	Office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.	65	35	23	12	0	6	0	6	147
Transportation and warehousing	Movement of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, support activities related to modes of transportation	45	23	22	10	3	0	0	7	110
Finance and insurance	Facilitating or engaging in transactions involving the creation, liquidation, or change in ownership of financial assets.	49	30	14	8	3	0	0	3	107
Wholesale trade	Wholesaling merchandise without transformation, services related to sales	24	11	9	9	0	0	0	2	55
Arts, entertainment, and recreation	Facility operation or service provision meeting varied cultural, entertainment, and recreational interests of their patrons.	23	4	3	8	0	0	0	5	43
Manufacturing	Transformation of materials, substances, components into new products	17	3	6	4	3	0	0	7	40
Educational services	For-profit or non-profit schools, colleges, universities, and training centers.	10	0	4	5	0	0	0	12	31
Information	Publishing, film and sound recording, broadcasting, telecommunications, Web search portals, data processing, information services industries	16	0	3	0	0	0	0	7	26
Industries not classified	Other	22	0	0	0	0	0	0	0	22
Utilities	Electric power, natural gas, steam supply, water supply, and sewage removal	0	0	0	0	0	0	0	4	4

Note: this data, from the U.S. Census Bureau's 2017 Economic Census of the U.S. Virgin Islands, also covers industries not represented in the USVI, including mining. Some industries prevalent in the USVI are not captured by this survey, including agriculture and public administration. This survey also does not capture the re-opening of the Limetree Bay Oil Refinery, which took place after this survey was conducted.

MATERIALS MANAGEMENT APPROACHES AND FACILITIES

To address the multiple discarded material streams generated by the residential and commercial/industrial sectors in the territory and develop effective materials management strategies in the USVI, it is important to understand the approaches to and facilities managing materials in the territory, which are described in this section. Using the results of the waste characterization studies to identify the relevant commodities in the territory, IEc conducted research on how each relevant commodity is managed on each island using the VIWMA website, publications from non-profit organizations, conversations with waste management officials and other organizations (e.g., stores, restaurants, hotels, farms, etc.) in the territory, and news articles.

Research indicates that the majority of the discarded materials in the USVI is landfilled and managed by the VIWMA. The VIWMA operates the two landfills in St. Thomas (Bovoni Landfill) and St. Croix (Anguilla Landfill) and transfer station in St. John (Susannaberg Transfer Station).[16] The Anguilla and Bovoni Landfills are nearing capacity and have been under court orders to close. Earlier this year, EPA approved the USVI's municipal solid waste landfill (MSWLF) permit program. This would allow the USVI to expand Bovoni Landfill and replace Anguilla Landfill with a new landfill on St. Croix through its approved permit program at its discretion. Since 2016, the VIWMA is working on implementing tipping fees for MSW, C&D, green waste, fill waste, and scrap metal at the two landfills in St. Thomas and St. Croix as well as the transfer station on St. John. The tipping fee for general MSW is $52.13 per ton, with the tipping fee for other materials ranging from $31.28 per ton (for fill material such as soil and sand) and $65.26 per ton (for C&D materials).[17] A portion of residents on St. Croix and St. Thomas participate in a curbside pick-up program for their waste, in which they pay haulers directly for waste collection services, and the remaining residents drop-off their waste at bin/disposal sites (at no cost) managed by the VIWMA.

While the vast majority of discarded in the USVI ends up at a VIWMA landfill, there are some policies in place to prevent material discards. For instance, since January 2017, all businesses in the USVI are prohibited from providing plastic checkout bags and non-recyclable paper bags for groceries and other merchandise.[18] In addition, since October 2019, all businesses in the USVI are prohibited from distributing disposal plastic drinking straws (with the exception of hospitals, nursing homes, hospices, and any other instances where non-plastic alternatives are not suitable due to mental or physical conditions).[19]

There are also some recycling and reuse programs and facilities. The VIWMA operates an electronic waste collection and recycling program. Due to high program costs and changes in funding allocations, the electronic waste program has seen changes to the scope of its collection operation over the years. Price uncertainty with recycling processors on the mainland has led to the VIWMA to switch receivers

[16] Note that waste brought to the Susannaberg Transfer Station in St. John are barged to the Bovoni Landfill in St. Thomas for landfilling.

[17] More information available here: https://www.viwma.org/index.php/businessinfo/tipping-fee

[18] More information available here: https://www.viwma.org/index.php/businessinfo/tipping-fee

[19] More information available here: https://stthomassource.com/content/2019/09/29/ban-on-plastic-straws-to-begin-october-1/

multiple times over the last decade, and the program's future remains uncertain.[20, 21] The most recent firm contracted to receive electronics from the USVI for recycling is ITAD Tech in Peachtree Corners, GA. ITAD Tech is a certified electronics recycler under ISO 14001:2015.[22, 23]

The remainder of the recycling and reuse programs and facilities in the USVI are largely operated by small-scale micro-enterprises and volunteer and non-profit programs. These are described in more detail below:

- There are several **plastics and aluminum recycling programs** across every island in the USVI. The Market[24] grocery stores on St. Thomas and St. Croix each host programs where residents can drop off their recycling. The recycling program in St. Thomas has processed about 100 tons of plastic and 30 tons of aluminum cans since starting in 2018. These programs operate on a small-scale, accounting for less than one percent of the plastic and aluminum waste streams. The recycling is exported to facilities in Puerto Rico and on the mainland. However, these programs are often run at a loss, due to the cost of shipping plastics to outside facilities. On the other hand, there are other businesses that are able to collect and recycle materials at a profit. For instance, Mendez Recycling, a business that collects metals and electronic waste, makes a profit by collecting and exporting materials to processing facilities in Puerto Rico. The VI Recycling Company in St. Croix also collects and ships metals for recycling.
- USVI has a few **reuse facilities** that will accept and re-sell secondhand items, such as used appliances, furniture, and clothing. The ReSource Depot on St. John is one example of this, where residents can donate used household items as well as construction tools and materials to be re-sold at the facility. [25] The ReSource Depot website indicates that the center has kept more than 112 tons of materials out of local landfills with a goal of 125 tons, accounting for less than one percent of the total annual bulk waste and textile waste streams. Another model is consignment, where people receive compensation for re-selling their used items; the ReUse Emporium offers a consignment option on St. Thomas. Other reuse and consignment facilities in the USVI include, but are not limited to: Home Again, Humane Society flea market, Salvation Army thrift shop, Cece's Closet, Animal Shelter Flea Market, The Women's Coalition Consignment Store, and Uniquities. While these options are not as convenient as disposal for residents, secondhand items are often less expensive than buying new products, which offers an incentive for residents to use these facilities. In addition, the St. John Eco Station is a business where customers can refill household cleaning fluids (e.g. laundry soaps, kitchen and bath cleaners) in reusable containers they already own.

[20] The St. Croix Source, 2021.

[21] C. Jacobs, phone conversation, 2021.

[22] C. Jacobs, phone conversation, 2021.

[23] The VIWMA is currently considering changes to its electronics waste recycling program, including the firm contracted to receive waste, due to high costs and complicated logistics in collection, packaging, and shipping.

[24] The Market grocery store was formerly called Plaza Extra. The Market hosts a plastics drop-off recycling program at both of its locations, one of which was known as the "Plaza Extra Grocery Store Recycling Campaign." To be consistent, we will refer to this program as "The Market Grocery Store Recycling Campaign" in this report.

[25] More information available here: https://islandgreenliving.org/resource-depot/

- In terms of **composting programs**, Island Green Living is currently running a Zero Waste Composting Pilot Program in St. John, where they use a brush chipper to process vegetative waste and offer mulch to the community at no cost. Farms also compost their own waste. For instance, Ridge to Reef Farm and Annaly Farms compost all organic waste on their farms. There are no commercial or large-scale composting programs on St. Thomas or St. Croix.
- Other organic material is diverted through **food donation programs and animal feed**. Organizations such as the Nana Baby Children's Home in St. Thomas and Helping Hands Food Pantry in St. John, collect food that would otherwise have gone to waste and redistribute this food to communities in need. [26] However, these are often one-off donations from individuals (e.g., residents), rather than sustained partnerships between large excess food generators (e.g., hotels, restaurants, supermarkets) and organizations in need. Most of the donated food accepted is typically from residents purchasing food for the purpose of donation, rather than donating food that would have otherwise gone to waste.[27] For instance, director of the Nana Baby Children's Home receives meal and packaged food donations from organizations, such as My Brother's Workshop and the Reformed Church of St. Thomas. The director of the home expressed a need for more fresh produce and indicated an interest in partnering with CostULess and other grocers, opening for an opportunity for waste diversion.[28] For animal feed, breweries reuse their spent grains as animal feed.[29] For example, Brew STX sends its spent grains to a local farm to serve as animal feed for chickens and pigs. However, like food donation, these are individual, informal efforts and not sustained, formal partnerships between breweries and farms in need.
- Lastly, the USVI is commencing efforts to **recycle glass** into glass cullet and sand. As recent as early 2021, University of the Virgin Islands scientist Howard Forbes secured the purchase of five glass crushers for community partners on St. Thomas and two for St. Croix, using funding from the Community Foundation of the Virgin Islands and the Ocean Conservancy.[30] The intended uses of the resulting glass cullet and sand include landscaping and manufacturing sandbags for use during hurricane season.[31, 32]

While some of these programs do not have physical facilities that process discarded materials in the territory, they still affect the waste stream and provide additional options for residents, businesses, and industries to divert their waste. One technical consideration for these facilities is that residents and commercial/industrial facilities must make the decision to separate and intentionally drop off their unwanted materials, rather than sending it to a landfill; without an incentive to do so, it can be challenging to encourage residents or businesses to change how they manage their discarded material streams.

[26] More information available here: https://nanababyhome.com/about/

[27] Nana Baby Children's Home, phone conversation, 2021.

[28] Nana Baby Children's Home, phone conversation, 2021.

[29] Brew STX, phone conversation, 2021.

[30] Cobb, 2021.

[31] Cobb, 2021.

[32] St. Croix Island Life Real Estate, 2021.

Although VIWMA officials expect that the volume of waste will largely return to the levels they were before COVID-19 at its facilities, it is important to note that several of smaller-scale volunteer-run programs have been on pause since the pandemic began. Even though VIWMA officials expect that the tourism and other sectors of the USVI are on a trajectory towards pre-pandemic activity, it is difficult to predict what the long-term effects of the pandemic might be on discarded material streams and small-scale materials management operations.

Exhibit 1-7 summarizes the facilities and programs in place that currently manage the USVI's waste stream, along with a high-level overview of their economic and technical considerations.

EXHIBIT 1-7. EXISTING AND PROPOSED MATERIALS MANAGEMENT FACILITIES IN THE USVI

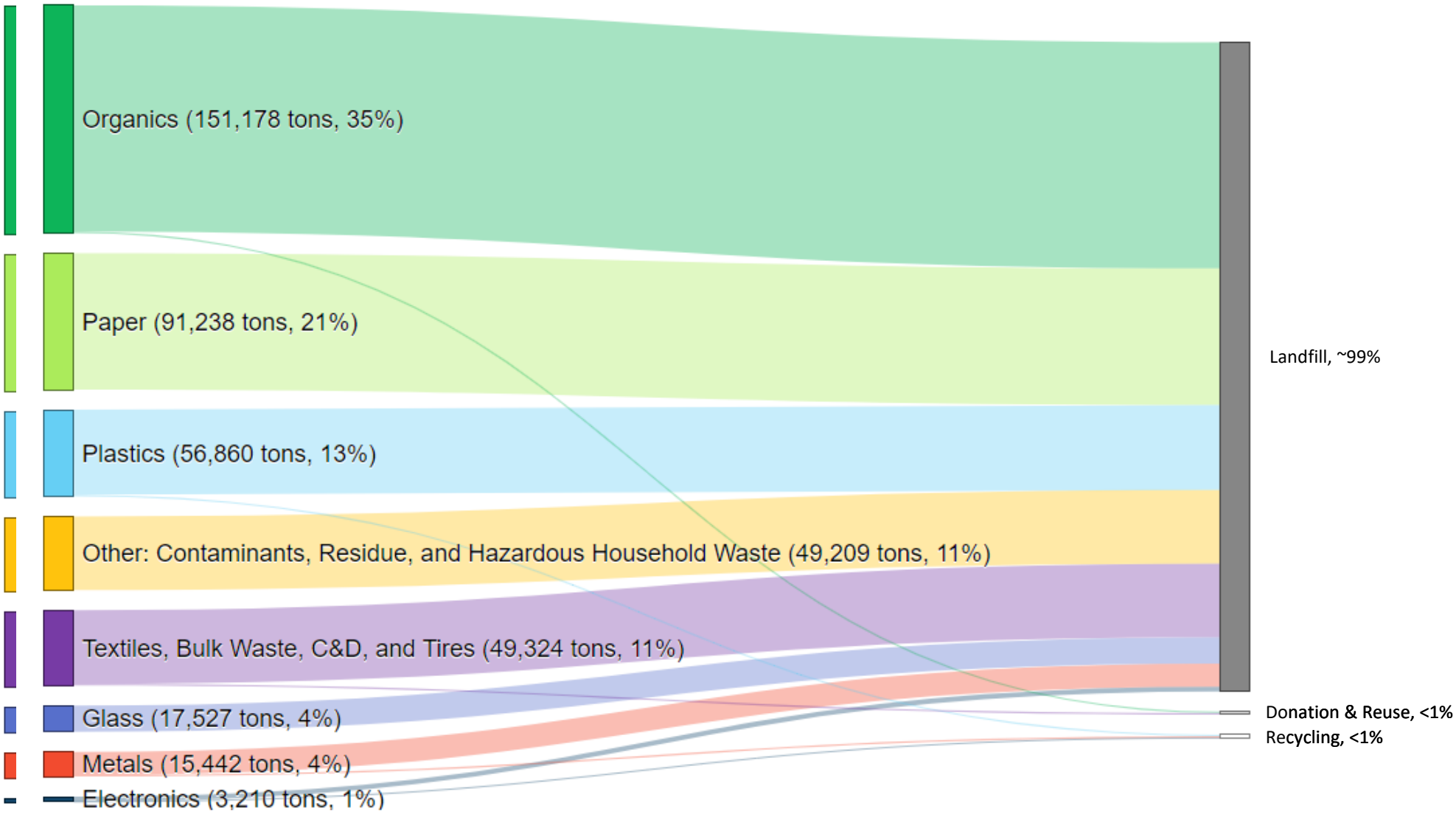
FACILITY/ MANAGEMENT APPROACH	TYPE OF APPROACH	STATUS	TYPES(S) OF COMMODITIES MANAGED	QUANTITY OF COMMODITIES MANAGED	ECONOMIC CONSIDERATIONS	TECHNICAL CONSIDERATIONS
VIWMA Facilities and Government Programs/Policies						
Bovoni Landfill, St. Thomas	Landfill	Existing (with proposed expansion)	Household waste, C&D, gas cylinders, junk cars, white goods, yard waste, green waste, seaweed, scrap metal	293,000 tons/year	Bovoni Landfill will institute tipping fees for solid waste haulers and other direct customers. The tipping fee for general MSW is $52.13 per ton, with the tipping fee for other materials ranging from $31.28 per ton (for fill such as soil and sand) and $65.26 per ton (for C&D material).	Bovoni Landfill is going to reach capacity within the next several years,[33] and the VIWMA has plans for its expansion. There is door-to-door waste pick-up available for 2,800 residents on St. Thomas. The remaining residents rely on using bin/disposal sites, which require maintenance and management from the VIWMA.
Anguilla Landfill, St. Croix	Landfill	Existing (with planned closure)	Household waste, C&D, gas cylinders, junk cars, white goods, yard waste, green waste, seaweed, scrap metal	140,000 tons/year	Anguilla Landfill has tipping fees for solid waste haulers and other direct customers.	Anguilla Landfill is going to reach capacity soon, and the VIWMA has plans for its closure. There is door-to-door waste pick-up available for 11,300 residents on St. Croix. The remaining residents rely on using bin/disposal sites, which require maintenance and management from the VIWMA.
Susannaberg Transfer Station, St. John	Transfer Station	Existing	Household waste, C&D, gas cylinders, junk cars, white goods, yard waste, green waste, seaweed, scrap metal	6,800 tons/year (only residential)	Susannaberg Transfer Station has tipping fees for solid waste haulers and other direct customers. Costs are associated with barging waste from the transfer station from St. John to the Bovoni Landfill on St. Thomas.	The waste at Susannaberg Transfer Station is shipped from St. John to the Bovoni Landfill on St. Thomas. St. John residents rely on using bin/disposal sites, which require maintenance and management form the VIWMA.
VIWMA Proposed Landfill, St. Croix	Landfill	Proposed	TBD	N/A	Building a new landfill will require upfront costs (to build the necessary infrastructure). Since this landfill is intended to replace Bovoni Landfill, the costs involved to operate and maintain the landfill will likely be comparable.	Building a new landfill requires sufficient land, and land that meets RCRA standards. Building a new landfill also provides an opportunity to implement new waste management programs (e.g. source separation).

[33] Recycling Today Staff, 2015.

FACILITY/ MANAGEMENT APPROACH	TYPE OF APPROACH	STATUS	TYPES(S) OF COMMODITIES MANAGED	QUANTITY OF COMMODITIES MANAGED	ECONOMIC CONSIDERATIONS	TECHNICAL CONSIDERATIONS
Department of Public Works Debris Removal	Debris Collection	2017-2018 Program	Vegetative debris, C&D, and white goods	750,000 cubic yards of vegetative debris, 121,000 cubic yards of C&D, 7,372 pieces of white goods	Costs associated with processing and shipping debris outside of USVI.	If certain debris, such as vegetative debris, are kept within the USVI, the territory needs space to store it.
VIWMA Electronic Waste Recycling Program	Recycling	Existing	Electronics	Unknown	Costs associated with collecting, packaging, insuring, and shipping collected electronics outside of USVI. Processors located on the mainland also charge fees for receipt of electronics for recycling.	Electronics need to be wrapped in plastic and palletized prior to off-territory shipment, a process that is both labor- and time-intensive in addition to expensive.
Plastic Bag Ban	Reduction Policy	Existing	Plastics	N/A	The Plastic Bag ban requires that business owners purchase alternative options, such as paper or reusable bags, to replace plastic bags.	The Plastic Bag Ban requires business owners to use alternative options (e.g. paper bags) or encourage customers to bring their own reusable bags.
Plastic Straw Ban	Reduction Policy	Existing	Plastics	N/A	The Plastic Straw ban requires that business owners purchase alternative options, such as metal straws, to replace plastic straws as well as equipment to sanitize and reuse them.	The Plastic Straw Ban requires business owners to use alternative options (e.g. metal) or encourage customers to forego straws.
Micro-Enterprises						
ReSource Depot, St. John	Reuse	Existing	Household items, furniture, appliances in working condition, tools and salvaged construction materials	145+ tons to date (since opening in 2012)	Customers can purchase secondhand household items at a reduced price.	The ReSource Depot depends on donations for household items, furniture, appliances, tools, and salvaged construction materials.
Aluminum Can Crusher (located at the ReSource Depot), St. John	Recycling	Existing	Aluminum beverage cans	400,000 cans or 7.5 tons (from 2014 to May 2019)	Residents can drop off aluminum cans at no cost. However, for Island Green Living there is a cost associated with shipping the baled cans to a facility outside of USVI.	Requires residents to drop-off cans and separate it from their other waste. Also requires Island Green Living to ship the bales to a facility outside of USVI.
The Emporiums: The ReUse Emporium (consignment shop) and ReNew Emporium (online store), St. Thomas	Reuse	Existing	Household items; discontinued/ overstocked furniture from big companies (e.g. Target, Wayfair, etc.)	7,500 square feet of warehouse space at ReUse Emporium; 40-foot container of items for ReNew Emporium every few weeks	Customers can purchase secondhand household items at a reduced price.	The ReUse Emporium depends on consigners who can provide household items that they can re-sell. The ReUse Emporium also depends on having enough space to store their products.

FACILITY/ MANAGEMENT APPROACH	TYPE OF APPROACH	STATUS	TYPES(S) OF COMMODITIES MANAGED	QUANTITY OF COMMODITIES MANAGED	ECONOMIC CONSIDERATIONS	TECHNICAL CONSIDERATIONS
Recycling companies such Mendez Recycling, St. John and VI Recycling Company in St. Croix	Recycling	Existing	Batteries, AC units, transmissions, copper, wire, and brass	Up to 1.5 tons/week	Mendez Recycling pays schools and community groups 18 cents per aluminum can. There are costs associated with shipping recycling to facilities outside of USVI.	Recycling requires resident drop-off materials. It also requires that residents separate their waste to determine what can be recycled.
USVI Zero Waste Composting Pilot Program, St. John	Composting	2020 Pilot	Vegetative debris	Unknown	Two part-time positions were created to manage and operate the composting equipment (brush chipper). The mulch processed from vegetative debris will be offered to the community at no cost.	The brush chipper and the mulch that it produces requires space and storage. The program is expected to hire two part-time workers (one brush chipping manager and a laborer).
St John Eco Station	Reuse	Existing	Household cleaning fluids	Unknown	The Eco Station owners have source their products in bulk and purchase dispensers for these products.	Customers are required to bring their own reusable containers when they purchase products at the Eco Station.
Volunteer and Non-Profit Programs						
The Market Grocery Store Recycling Campaign, St. Thomas	Recycling	Existing	Plastics, aluminum cans	100+ tons of plastic and 30+ tons of aluminum cans (since the start of the program in September 2018)	Costs associated with shipping plastics to recycling facilities outside of USVI. The owner of The Market that hosts this program runs the recycling program at a loss.	Recycling requires resident drop-off materials. It also requires that residents separate their waste to determine what can be recycled.
Plastic Drop Off Recycling Group, St. Croix	Recycling	Existing	Plastics	Unknown	Costs associated with shipping plastics to recycling facilities outside of USVI.	Recycling requires resident drop-off materials. It also requires that residents separate their waste to determine what can be recycled.
Beach Cleanup Events	Beach Debris and Plastics Collection	Existing	Plastics and other debris	Varies	Costs associated with processing and shipping debris outside of USVI.	These events rely on volunteer participation.
Food donation programs such as Nana Baby Children's Home, St. Thomas and Helping Hands Food Pantry, St. John	Food Donation	Existing	Excess food	70-105 meals/week	Costs associated with storing, managing, and distributing food donations.	The amount of food distributed depends on the volume of donations and the availability of space to store food donations.
Brew STX	Animal Feed	Existing	Spent grain	300 pounds/month	Costs associated with the transportation and storage of spent grains as animal feed to local farms.	Quantity produced depends on the demand for beer, which varies by season.

EXHIBIT 1-8. SUMMARY OF WASTE MATERIALS FLOWS AND MANAGEMENT IN THE USVI[34]



[34] Material flows to non-landfilling approaches are minimal. Recycling, donation, and reuse each address less than 1 percent of the waste stream in the USVI.

CHAPTER 2 | SUCCESSFUL EXAMPLES OF AND TECHNICAL AND ECONOMIC CONSIDERATIONS FOR IDENTIFIED MATERIALS MANAGEMENT APPROACHES

As most of the waste generated in the USVI is landfilled and the landfills in the territory are at or close to reaching capacity, landfill diversion and materials management approaches are a priority. Using EPA's waste hierarchy as a guiding framework, research identifies several material management approaches that may be effective at diverting specific materials flows from landfills in the USVI and providing raw materials, and in some cases, finished products, that can serve USVI and other market demands. Appendix A summarizes the all materials management approaches assessed but ultimately, not recommended by IEc (e.g., anaerobic digestion, on-islands metals recycling, etc.).

For successful implementation, the technical and economic considerations of each recommended approach must be understood, which are discussed in more detail in this chapter as well as successful examples of other countries and territories implementing these approaches. Policies and programs that can help with the implementation of materials management approaches are discussed as well.

The technical considerations outlined in this chapter consider the following:

- **Land:** The USVI's terrain is mostly hilly, rugged, and mountainous with little level land. Materials management approaches must be able to operate within this landscape.
- **Heavy Equipment:** Some materials management approaches require investment in heavy equipment or processing systems. The USVI must consider the availability and feasibility of procuring these pieces of heavy equipment and, for some equipment, the need for three phase electric power, for successful materials management operation.
- **Resilience:** The USVI is prone to intense weather events, such as hurricanes. The materials management approaches should be built with resilience in mind to withstand strong weather conditions and to be able to better manage future disaster debris.

The economic considerations outlined in this chapter consider the following:

- **Job creation:** The USVI currently has an unemployment rate of 8.66 percent, which is slightly above the average national unemployment rate.[35] The materials management approaches should contribute positively to the USVI's workforce.[36]
- **Capital and operating/maintenance costs:** The USVI requires a projected $60 million annually to manage its waste.[37] Given the significant costs, capital and operating costs for materials

[35] Macrotrends.net, 2010-2020.

[36] Studies indicate that reuse creates the greatest job creation potential while recycling and composting create significantly more jobs than incineration or landfilling. More information is available here: https://www.ecocyclesolutionshub.org/about-zero-waste/jobs-eco-impact/

[37] Baribeau, 2019.

management approaches should prioritize source reduction and on-island diversion opportunities that can significantly reduce waste generation and disposal. Solutions must be cost-effective to implement and manage over time, and fall within the USVI's waste management budgetary requirements.

- **Effects on import costs:** Given its island setting and economic dependence on tourism, the USVI spends around $938 million annually on imports.[38] Materials management approaches should contribute to economic self-sufficiency, potentially by reducing imports or creating value through exports.
- **Effects on export costs:** Shipping wastes off-island can be expensive. Shipping wastes off-island could cost the USVI around $45 million annually (not including the cost of collection).[39] On-island materials management approaches should serve as more cost-effective alternatives to exporting waste, except in cases where secondary materials have high resale value.

For materials management approaches of serious interest, it is recommended the USVI undertake a detailed technical and economic assessment with waste management engineers and experts to determine specific sites in the USVI that are feasible, availability of capital investments and financing arrangements, opportunities for local employment, and subsidy or government funding needs.

[38] U.S. Census Bureau, 2019.

[39] Carlson, 2019.

2.1 ORGANICS AND PAPER RECYCLING

ORGANICS AND PAPER COMPOSTING

Composting is a natural process of recycling organic material into a rich soil amendment. Composting can serve as a viable option to divert organic wastes (e.g., excess food, yard waste, lumber, wood pallets, and biosolids) and paper products (e.g., office paper and cardboard) from the landfill. These materials can be collected then composted to produce a valuable material (i.e., compost). Compost can then be distributed to landscapers, farmers, and other businesses and residents as valuable topsoil to promote agricultural productivity and/or used for engineering purposes (e.g., erosion control), further supporting the growth of more food and plants and reducing imports of fertilizer and topsoil.

As an example, Exuma Waste Management and Recycle Exuma (RE) worked with Sandals Emerald Bay resort to implement a composting program for organic materials and cardboard. This program utilizes a large quarry pit and water from a wastewater processing facility to maintain moisture levels as the compost accumulates in the dry season. The composting operation requires a full-time composting technician to collect and manage the organic material. The project composted 71 tons of organics and paper and the resulting compost is purchased and used by a tropical fruit tree business on the island.[40]

As another example, the resort community of Palmas del Mar (PDM) on the island of Puerto Rico composts in a closed loop cycle. PDM mulches its green waste (e.g., palm fronds, coconut shells, grass clippings and tree branches) and dries its biosolids near its wastewater treatment plant. Once dried, the biosolids and the mulch are combined and composted in windrows for about three months. Afterwards, the facility has produced a marketable compost material that is then sold to landscapers and the general public. Overall, this closed loop cycle saves PDM $60,000 annually in disposal costs.[41]

As another example, Guam has utilized recycled pallets as composting bins. Pallets are obtained directly from local businesses, manufacturers, and landfills. Once assembled, these composting bins hold about one cubic yard of yard materials and each bin costs no more than $30.[42] Lastly, Kauai has implemented a series of simple composting programs with the help of three regional composters and have been able to divert 75 percent of green and landscape waste from landfills.[43]

Implementing a composting program in the USVI could potentially divert around 242,000 tons of organic material and paper from the landfill annually, representing 56 percent of the waste stream in the USVI. As noted in Chapter 1, the Island Green Living Association is managing a USVI Zero Waste Composting Pilot Program in St. John. Compost efforts could be integrated with this pilot program and expanded to

[40] Sullivan Sealy and Smith, 2014.

[41] Trojak, 2010.

[42] Guam Solid Waste Authority.

[43] Harder, 2020.

St. Thomas and St. Croix. In addition, there is market potential to sell and use the compost produced, as USVI farms alone spend $93,000 annually on fertilizer.[44]

Compost can reduce agricultural water use and increase soil productivity. For instance, in Guam, a large commercial composter located on a farm has reported 25 percent increase in production when compost is applied.[45] Farms in the USVI already recognize the benefits of composting and are accustomed to this practice. For instance, recent conversations with farms in the USVI have brought to light that farms, such as Ridge to Reef Farm and Annaly Farms, compost and apply all organic waste on-site.[46,47]

The USVI can use policy to encourage composting. For instance, organics landfill bans have been used to divert organics from the landfills towards recovery and reuse. States such as California, Massachusetts, New York, Connecticut, and Vermont have instituted landfill bans for organic waste. A study on Massachusetts' landfill ban found that the ban had diverted about half a million ton of excess food from the landfill and created hundreds of jobs within the organics hauling and processing sector.[48]

The successful implementation of a composting program requires the consideration of many technical and economic factors, which are discussed in the sections below.

ORGANICS AND PAPER COMPOSTING – TECHNICAL CONSIDERATIONS[49]

Composting is a well-established materials management practice, but technical management to ensure clean input and proper processing is necessary. Composting requires a balanced mix of materials that are rich in nitrogen or protein (also known as "greens") and materials that are rich in carbon or carbohydrate (also known as "browns). The success of any compost project relies on the existence of naturally occurring microorganisms to breakdown organic waste and convert the waste into compost. "Greens" help the microorganisms grow and multiply quickly while the "browns" serve as a food source for the microorganisms and allow air to filter through. Materials such as excess food, and grass and leaf clippings serve as valuable sources of "greens" for a compost pile while materials such as wood waste (e.g., tree branches, lumber, wooden pallets) and paper waste (e.g., newspaper, cardboard, office paper) serve as valuable sources of "browns." The composting process generates heat that kills pathogens and insects. Compost pile temperatures must be measured routinely to ensure proper composting. Commercial composting takes months and can generate odors.

The Solid Waste Association of North America (SWANA) and U.S. Composting Council and other organizations provide in-depth compost operator trainings and certification programs that that have been offered in Guam and the Pacific Islands. One successful compost operator in Guam attended a week-long

[44] This figure does not account for other potential compost uses, including as a substitute for topsoil and use in landscaping, erosion control, and other agricultural purposes. Source: Quinn, 2020.

[45] T. Hood, phone conversation, 2021.

[46] Ridge to Reef Farm, phone conversation, 2021.

[47] Annaly Farm, phone conversation, 2021.

[48] ICF, 2016.

[49] The Cornell Waste Management Institute (http://cwmi.css.cornell.edu/composting.htm) offers more resources and general information on composting.

compost facility operator training on the mainland and found it to be a key aspect of his success as a compost facility operator.[50] Guam currently composts 18,000 tons of organic material annually. [51]

Given the scale of compostable materials generated, industrial composting techniques serve as a suitable option to process large quantities of organic material. These techniques are detailed below:

- **Windrow:** Windrow composting is an open-air process that places the composting material into long piles approximately 5 feet high called "windrows." These windrows are turned regularly to ensure that all the composting materials are exposed to the warm, moist center of the pile where bacterial activity produces heat that encourages further breakdown.
- **In-vessel:** In-vessel composting takes place in an enclosed environment and involves feeding organic materials into a drum, silo, concrete-lined trench, or similar equipment. This enables efficient control of environmental conditions such as temperature, moisture, and airflow. The material is mechanically turned or mixed to make sure the material is aerated to encourage bacterial activity. The size of the vessel can vary in size and capacity.
- **Aerated static pile:** In aerated static pile composting, organic waste is mixed in a large pile. To aerate the pile, layers of loosely piled bulking agents such as wood chips, and/or shredded newspaper are added so that air can pass from the bottom to the top of the pile. The piles also can be placed over a network of pipes that produces airflow in and out of the pile using air blowers that can be activated by a timer or temperature sensors.

Based on the quantity of organic and paper waste generated annually in the USVI, the composting methods would require around 2 to 13 acres of land as well as equipment such as garbage or dump trucks to collect and transport organic material and brush chippers or tub grinders to break up the larger pieces of organic material (e.g., wood). [52, 53] Depending on the method, additional equipment such as front-end loaders, bulldozers, composting vessels, and perforated pipes are required. For windrow and aerated static pile composting, the composting sites must built with adequate buffers and setbacks (i.e., located at least one foot above seasonal high water table and 100 feet away from residences and businesses) to prevent water contamination during periods of intense weather events, such as hurricanes and floods, and reduce odors.[54] As the organic waste is composted in an enclosed structure, in-vessel composting does not require buffers or setbacks but does require fencing around the structure to protect it from flying debris during intense weather events. In addition, composting requires preparation of materials prior to the composting process itself. For instance, it is important to remove contaminants (e.g., tape, tabs, staples, nails, etc.) prior to composting. Magnets and screens are required to remove such contaminants.

ORGANICS AND PAPER COMPOSTING – ECONOMIC CONSIDERATIONS

[50] T. Hood, phone conversation, 2021.

[51] T. Hood, phone conversation, 2021.

[52] Savage, 2008.

[53] Resource Recycling Systems (RRS), 2019.

[54] NC Disaster Information Center, 2016.

Depending on the composting technology selected, composting could cost $300,000 to $600,000 in capital costs and $50,000 to $225,000 in annual maintenance and operating costs. Despite these costs, composting programs have the potential to contribute positively to the economy. The alternative to composting is shipping the organic waste off-island as the landfills are nearing capacity. Exporting organic waste could cost $27 million annually based on weight.[55] In addition, USVI farms alone spend $93,000 on fertilizer and manure annually.[56] This established in-territory demand could be met in part by the production and distribution of domestically-produced compost, in addition to the product's use as a substitute for topsoil. Assuming these products are currently imported, at least in part, domestic compost production could offset these import costs. Lastly, composting programs can contribute to the USVI's labor force by creating 70 jobs, mostly for skilled equipment operators to operate the heavy equipment at compost facilities. [57]

EXHIBIT 2-1. ORGANICS AND PAPER COMPOSTING TECHNICAL CONSIDERATIONS

	WINDROW	IN-VESSEL	AERATED STATIC PILE
Land Requirements	Relatively flat land around spanning 13 acres and should be located with setbacks to reduce odor concerns	Relatively flat land spanning around 2 acres	Relatively flat land around spanning 13 acres and should be located with setbacks to reduce odor concerns
Heavy Equipment Requirements	• Garbage/dump trucks to collect organic waste • Brush chipper or a tub grinder to break up waste • Magnet and screens to remove contaminants • Front-end loader, bulldozer, or compost turner • Water source	• Garbage/dump trucks to collect organic waste • Brush chipper or a tub grinder to break up waste • Magnet and screens to remove contaminants • Composting vessel for in-vessel composting only • Water source	• Garbage/dump trucks to collect organic waste • Magnet and screens to remove contaminants • Brush chipper or a tub grinder to break up waste • Perforated piping • Water source
Resilience Requirements	Compost areas should be located at least one foot above seasonal high-water table and 100 feet away from residences and businesses	Compost areas should have fencing build around it to protect composting vessels from flying debris	Compost areas should be located at least one foot above seasonal high-water table and 100 feet away from residences and businesses

EXHIBIT 2-2. ORGANICS AND PAPER COMPOSTING ECONOMIC CONSIDERATIONS

[55] Carlson, 2019.

[56] U.S. Department of Agriculture, 2020.

[57] Platt, 2013.

	COMPOSTING ECONOMIC CONSIDERATIONS
Jobs Created	70 jobs (e.g., skilled equipment operators for windrow turners, front-end loaders, and grinders)
Capital Costs	Ranges from $300,000 to $600,000
Operating/ Maintenance Costs	Ranges from $50,000 to $225,000 annually
Effects on Import Costs	USVI farms spend $93,000 of fertilizer annually; composting could offset this cost.
Effects on Export Costs	Exporting organics for landfilling could cost $16.8 million annually

2.2 GLASS RECYCLING

GLASS RECYCLING

Due to the relatively small scale of the glass waste stream on the USVI, and the lack of in-territory glass production, the recycling of glass into new glass is not considered a viable strategy for the territory, as detailed in Appendix A. The recycling of glass into other usable products is, on the other hand, an option that can be affordably scaled to manage any amount of glass waste. Processing involves crushing and cleaning glass into new product streams, with the size of the new particles adjustable to the future end use. Processed glass can be recycled into for the following applications:

- Glass cullet, for use as a fill material in construction applications, such as pipe bedding and embankments, or as "glass mulch" for landscaping.
- Ground-glass pozzolan for use as a cement replacement in concrete.
- Silica sand, for use in golf course construction, constructed wetland development, landscaping, beach restoration, and the manufacture of sandbags for hurricane resilience.
- Art glass products, such as suncatchers and jewelry.

As an example, Bermuda has a materials recovery facility that recycles about 600 tons of materials per year.[58] The facility processes and finely crushes recycled glass so that the resulting sand is used for filtration, golf courses, and soccer fields on the island. St. Martin has similar glass recycling initiatives. The island collects and recycles glass to produce PGA landscaping, filtration sand for utility pipe bedding and drainage, and engineered construction aggregate.[59] The use of ground glass as a concrete substitute for construction applications is an emerging opportunity that Guam is piloting.[60] This pilot requires coordination between the glass processing facility, concrete producers, and construction companies. A new ASTM Standard C 1866/C 1866 M provides technical guidance on the use of ground glass.[61] In the Cook Islands, the majority of glass is shipped to New Zealand for recycling, but some remains on the island and is used in concrete manufacturing. [62] Palau also successfully crushes glass for reuse on the island.[63]

[58] Clarkson, 2020.

[59] Andela, 2020.

[60] T. Hood, phone conversation, 2021.

[61] Kaminsky, 2020.

[62] Asian Development Bank, 2014a.

[63] Asian Development Bank, 2014b.

In addition, the British Virgin Islands hosts a not-for-profit organization, called Green VI Glass Studio. Green VI collects glass that would have otherwise been landfilled to produce artwork made from glass, such as figurines, that are then sold as gifts and mementos to tourists. The organization uses approximately 400 pounds of discarded green and clear beer bottles per week.[64]

GLASS RECYCLING - TECHNICAL CONSIDERATIONS

In terms of technical considerations, glass processing systems are scalable depending on the quantity of glass needing to be processed, with potential systems for the USVI ranging from one-half ton per hour to 20 tons per hour. The one-half ton per hour system could only process around seven percent of the USVI's annual glass waste each year, while the twenty ton per hour system could handle all of the USVI's annual waste.[65] The required footprint (indoor or outdoor) for these systems ranges between 100 and 2,500 square feet.[66] Additional storage space for glass both pre- and post-processing may be necessary. Operators would need to be trained to use and maintain the new systems.

The USVI already has the equipment to recycle glass. As recent as early 2021, University of the Virgin Islands scientist, Howard Forbes, secured the purchase of five glass crushers for community partners on St. Thomas and two for St. Croix, using funding from the Community Foundation of the Virgin Islands and the Ocean Conservancy.[67] Collected glass is to be recycled as glass cullet and sand for landscaping and manufacturing sandbags for use during hurricane season.[68, 69, 70]

EXHIBIT 2-3. GLASS RECYCLING TECHNICAL CONSIDERATIONS

	GLASS RECYCLING TECHNICAL CONSIDERATIONS
Land Requirements	Up to 2,500 square feet
Heavy Equipment Requirements	Glass processing systems, such as those produced by Andela (the USVI already has five glass crushers), and glass furnaces for art applications
Resilience Requirements	If stored outdoors, the glass processing system will need to be protected from potential storm debris

While art glass applications would not divert significant quantities of glass, they could support island tourist outreach tours and souvenir sales. Art glass applications typically require a glass furnace, which

[64] GreenVI, 2019b.

[65] Estimates calculated assuming the system is operated eight hours a day, 300 days a year for the small system. The larger system would only need 106 eight-hour days of operation to process all of the USVI's current annual glass waste.

[66] Andela, 2020.

[67] Cobb, 2021.

[68] Cobb, 2021.

[69] St. Croix Island Life Real Estate, 2021.

[71] Mobile Glassblowing Studios, LLC, 2020.

would need to be housed in a facility that is protected from potential storm debris. Glass furnaces are typically 56 inches in height, 31 inches in width. and 60 inches in length and weigh 750 pounds.[71]

GLASS RECYCLING - ECONOMIC CONSIDERATIONS

The cost impacts of glass recycling depend on the scale of the glass pulverizing system installed. The smallest systems, processing around one-half ton of glass per hour, would cost around $28,000 in upfront capital costs, with annual operating costs around $8,400.[72] A larger system, processing up to 20 tons per hour, would have capital costs up to $350,000 and annual operating costs of $16,900.[73] Glass furnaces for art applications cost on average $10,000 in upfront capital costs, with annual operating costs of around $1,000 to power and clean the furnace annually.[74] Recycling glass within the USVI is cost effective as the alternative to recycling is shipping glass waste off-island for disposal as landfills are nearing capacity. Exporting glass waste for landfilling could cost $1.9 million annually based on weight.[75]

Glass recycling could also contribute positively to the economy as glass recycling would create jobs by requiring one to two operators to operate the equipment. [76] Art glass applications could also provide local economic benefits by creating one or two jobs for managing the art space. In addition, the USVI imports sand and gravel from other islands; glass recycling could offset some of those costs.

EXHIBIT 2-4. GLASS RECYCLING ECONOMIC CONSIDERATIONS

	GLASS RECYCLING ECONOMIC CONSIDERATIONS
Jobs Created	2 to 4 jobs created (depending on the size of glass processing system and scale of art operations)
Capital Costs	$28,000 to $350,000 (depending on the size of glass processing system – the USVI already has five glass crushers) and $10,000 for a glass furnace for art applications
Operating/ Maintenance Costs	$8,400 to $16,900 (depending on the size of glass processing system) and around $1,000 for power and clean the furnace for art applications
Effects on Import Costs	The USVI imports sand and gravel from other islands; glass recycling could offset some of those costs
Effects on Export Costs	The alternative of exporting glass waste for landfilling could cost $1.9 million annually

[71] Mobile Glassblowing Studios, LLC, 2020.

[72] Andela, 2020.

[73] Andela, 2020.

[74] Galitsky et al., 2008.

[75] Carlson, 2019.

[76] Andela, 2020.

2.3 METALS RECYCLING

METALS RECYCLING

Recycling metals, both alumnium and ferrous, requires collecting metal materials that would otherwise be landfilled and processing them into new and useful materials or proucts. Because of the high capital costs and volume of waste needed to ensure a viable process, building and operating a metal recycling facility is not a cost-effective option for the USVI, as detailed in Appendix A. However, recyclers are willing to pay for recycled metal, thus, exporting metals to recycling facilities outside the territory emerges as a cost-effective opportunity. Creating a system to export metals for recycling requires that metal materials from residents and businesses in the USVI are collected, baled, and then shipped for recycling. For instance, Barbados hosts a robust metal recycling program. The island collects both ferrous and non-ferrous metals, sorts and bales the materials, then exports them for recycling.[77]

Implementing a metal recycling program in the USVI has the potential to divert around 15,500 tons of waste from the landfill annually, representing less than 5 percent of the waste stream in the USVI. The global scrap metal market remains relatively stable, so the USVI would be able to consistently profit from selling its metal waste to recycling facilities. As noted in Chapter 1, the VIWMA facilities already process some scrap metal, and there are several volunteer-run operations and small businesses (e.g., Mendez Recycling and VI Recycling Company) that bale and ship metals for recycling Thus, building a program from this foundation has the potential to divert a larger proportion of this material from the landfill.

The closest metal recycling facilities to the USVI are in Puerto Rico, such as Borniquen Metal Scrap, Procesadora De Metales LLC, Homeca Recycling Center, and Caribbean Recycling Group, Inc. A representative from Borniquen Metal Scrap indicated that their facility would be able to accept about 15,000 tons of metals from the USVI each year, and that the USVI would not have to make shipments on a consistent basis. The representative did not provide a cost estimate for accepting metals because the market price for metals vary daily. However, they mentioned that the costs to process metals in Puerto Rico might be higher than the costs to process on the U.S. mainland or in China because the energy costs in Puerto Rico are higher. The USVI would have to arrange and cover the cost of shipping to the Borniquen Metal Scrap facility.[78] A representative at Procesadora De Metales indicated that their facility would be able to accept about 15,000 tons of metals from the USVI each year, and that the USVI would not have to make shipments on a consistent basis. The representative mentioned that their facility has accepted metals from the USVI before. Their company takes care of shipping costs; the cost of shipping a single container (40’ by 8’ by 8’ 6”) from the USVI to Puerto Rico ranges between $1,000 and $1,500. Prices vary due to market values, but Procesadora De Metales generally purchases aluminum for about

[77] Barbados Solid Waste Management Programme, 2018.

[78] Borniquen Metal Scrap, phone conversation, 2021.

$0.40/lb and copper for $2.60/lb.[79] In addition to working with nearby metals recycling companies, the USVI could also look to partner with shipping companies to save costs on recycling. A representative from Tropical Shipping Company indicated that their company offers preferred shipping rates for certain commodities, and they would be willing to work with the Waste Management Authority to negotiate a discounted price for shipping materials for recycling.[80]

METALS RECYCLING – TECHNICAL CONSIDERATIONS

Land requirements for a metal collection program are minimal as the equipment is portable and collection sites already exist in the USVI. However, placing equipment near shipping ports may make transferring baled metals to ports more convenient. In terms of equipment, a territory-wide metal collection program would require dump trucks to collect and haul waste, as well as balers to crush waste. Balers can range in size, but there are models that are around 10" by 10", with a 2.8 ton/hour capacity.[81] This is sufficient to meet the quantity of waste generated in the USVI, especially if balers are stationed at each of the VIWMA facilities. Additionally, the USVI already operates balers; it would be useful to explore the status of these balers before purchasing new ones as well as metal sorting and processing equipment to increase the convenience of sorting metals as well as its resale value. For resilience purposes, the equipment should be stored in an area or facility where it can be protected from flying debris.[82]

EXHIBIT 2-5. METALS RECYCLING TECHNICAL CONSIDERATIONS

	METALS RECYCLING TECHNICAL CONSIDERATIONS

Land Requirements	• Minimal and flexible; enough space to fit:
	  ○ Heavy equipment; at least 10" by 10" (width x height)
	  ○ Metal waste collection areas (some already exist)

Heavy Equipment Requirements	• Dump trucks to collect and haul metal waste • Baler to crush waste • Sorting and processing equipment
Resilience Requirements	Equipment should be stored in areas that are protected from flying debris

METALS RECYCLING – ECONOMIC CONSIDERATIONS

Depending on the equipment selected, a metal collection program could cost $100,000 to $1.5 million in capital costs and $440,000 in annual maintenance and operating costs. [83, 84] While a metal recycling program poses some upfront and annual costs, a recycling program has the potential to contribute positively to the USVI economy and serve as a cost-effective option for managing metal waste. Exporting

[79] Procesadora De Metales, phone conversation, 2021.

[80] Tropical Shipping Company phone conversation, 2021.

[81] Metso, 2020.

[82] U.S. Environmental Protection Agency, 2010.

[83] U.S. Environmental Protection Agency, 2002b.

[84] Phillips, 2001.

metal waste for landfilling could cost up to $1.7 million annually based on weight.[85] However, depending on the type of metal, metals can be valued anywhere from $100 per ton to $2,000 per ton for recycling.[86] Conservatively assuming that all metal waste in the USVI is valued at $500 per ton, the annual value of discarded metal in the USVI would be around $7.7 million. This greatly exceeds the costs of export and maintenance, making exporting metals for recycling a cost-effective option for the USVI. Lastly, a metal recycling collection program could contribute positively to the USVI economy by creating up to 18 jobs for technicians to operate equipment, manage collection and exporting, and conduct collection.[87]

EXHIBIT 2-6. METALS RECYCLING ECONOMIC CONSIDERATIONS

	METALS RECYCLING ECONOMIC CONSIDERATIONS
Jobs Created	Up to 18 jobs (e.g., metal sorters, skilled equipment operators)
Capital Costs	$100,000 to $1.5 million (cost of a baler for each island)
Operating/Maintenance Costs	$310,000 (mostly fuel and labor costs)
Effects on Import Costs	None (since materials would be recycled outside of the USVI)
Effects on Export Costs	Exporting metal waste for landfilling could cost $1.7 million annually

[85] Carlson, 2019.

[86] iScrap App, 2020.

[87] U.S. Environmental Protection Agency, 2020b.

2.4 ELECTRONICS RECYCLING

ELECTRONICS RECYCLING

Electronics recycling is the process of media separation and materials reprocessing, as well as destruction of stored data. This serves as an alternative to direct landfilling of electronics, which can lead to the leaking of toxic and hazardous materials, as electronics contain dangerous heavy metals such as mercury, lead, and cadmium. Additionally, the security of potentially sensitive digital data stored on devices can be compromised during the landfilling process. Certified electronics recyclers follow protocols for the safe material destruction of all devices and stored data.[88]

Collection of electronics for recycling is currently practiced by the VIWMA. The VIWMA collects and ships electronics to recyclers located relatively close by. The most recent firm contracted to receive electronics from the USVI is ITAD Tech in Peachtree Corners, GA, which is certified under ISO 14001:2015. Other firms the VIWMA has used in the past include Heizwerthy in Decatur, GA and TradeMark Metals in Tampa, FL.[89]

Recycling efforts could be expanded to collect discarded electronics throughout the territory.[90, 91] In addition, the VIWMA could consider exploring contracts with closer, certified recyclers, such as Piranha International Limited in Trinidad and Tobago, or DRE Repair Services in the Dominican Republic, which in addition to offering recycling services, hosts a buy-back program on certain electronics such as mobile phones, as these devices also valuable metals such as gold, silver, platinum, and copper.[92] In addition to working with nearby electronics recycling companies, the USVI could also look to partner with shipping companies to save costs on recycling. A representative from Tropical Shipping Company indicated that their company offers preferred shipping rates for certain commodities, and they would be willing to work with the Waste Management Authority to negotiate a discounted price for shipping materials for recycling.[93]

ELECTRONICS RECYCLING – TECHNICAL CONSIDERATIONS

The barriers to expanding electronics waste recycling in the USVI is primarily on waste collection. As of 2012, the VIWMA's formal electronic waste collection program was on hold due to budget cuts, though employees continue to pick-up of discarded electronics at the homes of seniors and those with disabilities.

[88] U.S. Environmental Protection Agency, 2019.

[89] C. Jacobs, phone conversation, 2021.

[90] Virgin Islands Waste Management Authority, 2020.

[91] Huff, 2015.

[92] Further information for each company is available here: https://www.piranhatt.com/ and https://encorerepair.com/

[93] Tropical Shipping Company, phone conversation, 2021.

Other USVI residents are encouraged to drop off electronics at VIWMA facilities and convenience centers on each island. The VIWMA then sorts and packs electronic waste into 40-foot marine containers for shipment. Because of the lack of a formal electronics collection program, staff also must patrol dumpsters to determine whether electronics have been improperly disposed of alongside normal MSW.[94]

Technical considerations for off-territory electronic waste recycling are relatively minimal. Collected electronics must be stored with a method that protects it from extreme weather conditions. If items are damaged, they could dispense dangerous constituents (e.g., lead from broken television screens). This storage requires space, but since the VIWMA ships multiple containers per year, an expanded territory-wide electronics collection program would not pose significant additional space requirements. Additional requirements for heavy equipment likely do not extend beyond what the VIWMA already has for day-to-day operations, such as forklifts.[95]

EXHIBIT 2-7. ELECTRONICS RECYCLING TECHNICAL CONSIDERATIONS

	ELECTRONICS RECYCLING TECHNICAL CONSIDERATIONS
Land Requirements	Minimal; enough space for 40-foot marine containers to store electronics while preparing for shipment
Heavy Equipment Requirements	Forklifts (already owned by the VIWMA)
Resilience Requirements	Electronic waste should be stored indoors or in impervious containers

ELECTRONICS RECYCLING – ECONOMIC CONSIDERATIONS

The current electronics recycling program costs the VIWMA around $82,000 annually in operating costs.[96] These include the costs of shipping electronic waste to a Certified Electronics Recycler and fees applied by the recycling company for certain materials, such as televisions, which require additional care due to their lead content. For the most part, most electronic waste recycling facilities will accept electronic waste for free, provided the USVI pays for shipping.[97] As of 2012, the VIWMA ships roughly one 40-foot container of electronic waste per month, at a cost of around $5,000 per shipment.[98] Because the VIWMA already recycles electronic waste, additional job creation from continuing this program is likely to be minimal. If the program were to be expanded to include additional electronic waste pickup opportunities, both job creation and operating costs may increase.

EXHIBIT 2-8. ELECTRONIC WASTE ECONOMIC CONSIDERATIONS

[94] The St. Thomas Source, 2012.

[95] Minnesota Pollution Control Agency, 2011.

[96] The St. Thomas Source, 2012.

[97] E-Cycling Puerto Rico, 2011-2018.

[98] The St. Thomas Source, 2012.

	ELECTRONIC WASTE ECONOMIC CONSIDERATIONS
Jobs Created	None beyond current operations
Capital Costs	None beyond current operations
Operating/ Maintenance Costs	Around $82,000 annually (for shipping to a Certified Electronics Recycler)
Effects on Import Costs	None
Effects on Export Costs	None, already spending approximately $82,000 annually for shipping

2.5 DONATION, CONSIGNMENT, REPAIR, AND LENDING LIBRARIES

DONATION, CONSIGNMENT, REPAIR, AND LENDING LIBRARIES

Donating, consignment, repair, and lending libraries serve as meaningful methods to reduce and reuse materials, such as bulk, electronics, textiles, and excess food.

- **Donation** programs allow people to give their excess materials to organizations that serve the community, reuse centers, thrift stores, or food pantries, providing an opportunity not only to reduce waste, but provide materials for others in need. Donation also reduces or eliminates costs for those purchasing those materials. As discussed in Chapter 1, the USVI already has a few organizations and businesses that rely on donation, such as the ReSource Depot, which is a reuse center that collects and distributes household items, and the Helping Hands Food Pantry, a food pantry for the community that relies on food donations.
- **Consignment** programs offer a business model where individuals can provide their used items to stores, and once those stores sell their items, they are compensated. This compensation can serve as an incentive for individuals to re-sell, rather than discard, their used items.
- **Repair** programs enable people to fix their broken items, through events like Repair Cafes, or through repair centers. Repair can be especially useful in an island setting, where acute events, such as storms and natural disasters, can cause an inundation of damage.
- **Lending libraries** are a collection of items available for a community to borrow and use for little to no cost. Like a library of books, a lending library enables people to "check out" items (e.g., tools) for a given period of time, so individuals can access the items they need without the barrier of purchase and maintenance. A lending library might also have an educational component, where librarians can teach community members how to use and care for different items.

Many areas use donation, consignment, repair, and lending libraries as meaningful methods to reduce waste and manage materials. As an example, the city of Federal Way in Washington state created the South King Tool Library, a "tool lending library" where tools are loaned to members of the community for little to no cost, reducing the number of excess, unused tools in the city. Since opening in June, South King Tool Library has already made 450 loans. Paired with the tool lending library, the city organizes Repair Café events, where residents can get help to fix their broken household items. Federal Way finds that the combination of the tool lending library and repair-oriented events are effective at encouraging a culture of repair within the community.

As another example, Hawaii has integrated reuse at its transfer stations. The state upgraded eight of its transfer stations so that they now include reuse centers.[99] Residents can drop off items for reuse that range

[99] Hood, 2020.

from clothing to toys to other, unwanted but usable household items. People can shop at these centers and purchase secondhand goods at discounted prices, reducing the cost of materials for residents and the cost of landfilling for the state. These reuses centers are built in tent-like structures so that they are easily disassembled in the event of extreme weather (e,g., hurricanes).

There are also exisiting initiatives to divert perishable items, such as food, from landfills. As an example, Feeding America, one of the biggest hunger relief organizations in the country, operates a food bank in Puerto Rico. The food bank is managed by 19 employees and accepts excess food that would have otherwise been disposed of from hotels, restaurants, and supermarkets. Feeding America in Puerto Rico serves over 1.1 million people annually, and distributes over 13.5 million pounds of excess food annually.

As noted in Chapter 1, there are already organizations and businesses running reuse centers, donation programs, and consignment businesses in the USVI. Using these programs as a foundation, the USVI can expand its efforts to build programs to facilitate widespread source reduction and reuse. The widespread implementation of reuse and waste prevention programs require a concerted education program. The USVI can dessiminate information about these programs through the use of social media and other promotional/marketing campaigns.

DONATION, CONSIGNMENT, REPAIR, AND LENDING LIBRARIES – TECHNICAL CONSIDERATIONS

In terms of technical considerations, both consignment and donation require having space designated to store and re-distribute (or re-sell) items. Existing donation organizations and consignment businesses have used 20- or 40-foot shipping containers to store items and have used 1,800 square feet of warehouse space.[100] Reuse centers are easily scalable, enabling them to grow in size and capacity as demand increases. For food donation specifically, refrigerators are needed to store perishable food and pantry space is needed to store non-perishable food. Repair programs have very few technical considerations beyond needing space to host repair workshops, events, and centers. The success of repair programs, as well as donation and consignment programs, are also reliant on participation, which can be encouraged through community engagement, publicization, and incentive systems.

EXHIBIT 2-9. DONATION, CONSIGNMENT, REPAIR, AND LENDING LIBRARIES TECHNICAL CONSIDERATIONS

	TECHNICAL CONSIDERATIONS
Land Requirements	Minimal; enough land for • storage container and a temporary structure or warehouse space to store/sell/distribute items or host repair events and equipment • refrigeration to store perishable food items
Heavy Equipment Requirements	None
Resilience Requirements	Items should be stored in structures or containers that are protected from flying debris

[100] Island Green Living Association, 2019.

DONATION, CONSIGNMENT, AND REPAIR – ECONOMIC CONSIDERATIONS

Depending on scale, a donation/consignment/repair/lending center could cost around $30,000 in capital costs and around $53,000 annual maintenance and operating costs (the bulk of which is allocated to renting space for the center).[101, 102] However, if reuse centers were incorporated in existing space (e.g. VIWMA facilities or bin sites), then the costs would be significantly reduced.

Donation, consignment, repair, and lending can have a positive impact on the economy by creating six to 15 jobs, mostly for center or store managers, community event organizers, and cash register positions.[103, 104] In addition, a portion of the cost that USVI spends on importing textiles, electronics, food, and bulk items cost could be offset by donation, consignment, repair, and lending programs as well.

EXHIBIT 2-10. DONATION, CONSIGNMENT, REPAIR, AND LENDING LIBRARIES ECONOMIC CONSIDERATIONS

	DONATION AND CONSIGNMENT ECONOMIC CONSIDERATIONS
Jobs Created	6 to 15 jobs (cash register positions, managers, coordinators)
Capital Costs	Around $30,000 (cost of renting shop space, storage space, marketing, and storing equipment)
Operating/ Maintenance Costs	Around $53,000 annually
Effects on Import Costs	A portion of import costs spent on textiles, electronics, food, and bulk items could be offset by donation, consignment, and repair programs
Effects on Export Costs	None

[101] Hood, 2020.

[102] Profitable Venture Magazine.

[103] Assuming that there is one donation or consignment center on each island and at least one community with repair events on each island.

[104] Hood, 2020, and The Emporiums, 2005-2020.

2.6 TEXTILES RECYCLING: UPCYCLING AND DOWNCYCLING

TEXTILES RECYCLING: UPCYCLING AND DOWNCYCLING

While off-island recycling is a possibility for the USVI, the number of options for facilities in the Caribbean are limited and the costs of coordinating an island-wide collection and shipping program would likely be high due to distance between the USVI and available textile recycling facilities. For instance, Martex Fiber is a large company that has textile recycling facilities located in Nicaragua, and Honduras, and the mainland.[105]

Instead, the USVI could look to more cost-effective recycling options such as local recycling alternatives. These alternatives, such as transforming used textiles into upcycled clothing pieces, shopping bags, blankets, and other items have the potential to divert discarded textiles in the USVI. Local textile upcycling programs could come in the form of DIY events for the community, micro-enterprises, and educational workshops. Upcycling textiles has the potential to dovetail with existing USVI efforts to reduce discarded materials. For instance, micro-enterprises could make reusable bags to sell to those seeking to comply with the plastic bag ban. This model has gained traction elsewhere. A micro-enterprise in Canada collects discarded clothing and sews the fabric together to produce reusable bags and totes of various sizes ranging in price from $8 to $12 per bag.[106]

Downcycling is also a possible local recycling alternative. Textiles that have reached the end of their usable life can be downcycled and cut down into cleaning and wiping rags or used in local pet shelters. In addition, recycled textile products could also fulfill the needs of sustainable materials management programs, such as providing rags for a composting system. As an example, PR Textile Recycling is a company that provides textile collection services to 60 municipalities in Puerto Rico through more than 1,000 collection boxes stationed on the island. 30 percent of collected textiles are cut into cleaning/polishing cloths that are used in surrounding shops and industries.[107]

TEXTILE RECYCLING: UPCYCLING AND DOWNCYCLING – TECHNICAL CONSIDERATIONS

Local textile upcycling and downcycling programs have very few technical considerations beyond needing space to host textile repair events and workshops and space for micro-enterprises to operate their businesses. Local-scale programs require concurrent educational campaigns to inform USVI residents about how to up/downcycle and transform their used textiles. Since local efforts are reliant on individual consumer choices and community participation, it is important for the USVI to encourage and enable access to textile up/downcycling opportunities through robust educational messaging and resources.

[105] Martex Fiber, 2014.

[106] CBC Kids News, 2020.

[107] PR Textile Recycling, 2020.

EXHIBIT 2-11. TEXTILE UPCYCLING AND DOWNCYCLING TECHNICAL CONSIDERATIONS

	TEXTILE UPCYCLING AND DOWNCYCLING TECHNICAL CONSIDERATIONS
Land Requirements	Minimal; enough space for • hosting textile up/downcycling events • office/store space (if supporting micro-enterprises)
Heavy Equipment Requirements	None
Resilience Requirements	None

TEXTILE RECYCLING: UPCYCLING AND DOWNCYCLING – ECONOMIC CONSIDERATIONS

Textile upcycling or downcycling program costs are minimal, especially if events are hosted in existing venues and volunteers assist with staffing workshops. However, a more established textile program could involve needing permanent spaces for textile upcycling and downcycling workshops and events, as well as space for micro-enterprises to operate their businesses. The costs of textile materials can range depending on how much the textiles are manipulated. Basic equipment needed are often ones that people might already own (e.g., scissors, sewing machines, etc.) Others might need textile dyes if they hope to change the color of the textile upcycled. Depending on their number and scale, textile programs could contribute positively to the USVI's labor force, creating six to nine jobs mostly for community event organizers, micro-enterprise owners, and skilled tailors.[108] In addition, textile programs would prevent need for exporting textile waste for landfilling, which could cost $1.3 million annually.[109] As textile programs and micro-enterprises can create reusable goods, these upcycled and downcycled products can replace a portion of the amount spent importing bags, blankets, and cleaning rags.

EXHIBIT 2-12. TEXTILE RECYCLING: UPCYCLING AND DOWNCYCLING ECONOMIC CONSIDERATIONS

	TEXTILE UPCYCLING AND DOWNCYCLING ECONOMIC CONSIDERATIONS
Jobs Created	6 to 9 jobs (mostly for community event organizers, micro-enterprise owners, and skilled tailors)
Capital Costs	Minimal; includes cost of • equipment needed to recycle materials (i.e. tools to clean cut, and sew materials) • property (if renting a permanent spot for micro-enterprise or events)
Operating/Maintenance Costs	Minimal; includes cost of property rental or event space rental and labor
Effects on Import Costs	Recycled textile products can replace a portion of the amount spent importing bags, blankets, and cleaning rags
Effects on Export Costs	Exporting textile waste for landfilling could cost $1.3 million annually

[108] Assuming that there is one textile recycling event organizer per island and one micro-enterprise per island.

[109] Carlson, 2019.

2.7 ANIMAL FEED

ANIMAL FEED

Animal feed provides opportunities to recycle and reuse discarded organic materials. Materials commonly reused for animal feed range from animal protein or by-products to spent grains created during the brewing of beer. For instance, on Cook Islands larger resorts provide food scraps to local piggeries in exchange for discounted pork.[110] The reuse of certain discarded organic materials as animal feed on the USVI is heavily depended on current regulatory safety standards.

The process of feeding animals discarded organic materials is regulated by the Swine Health Protection Act (SHPA), the Ruminant Feed Ban Rule, and the Food Safety Modernization Act (FSMA) Rules on Preventive Controls. The FSMA sets out general safety guidelines for the production and distribution of food waste as animal feed. Facilities that produce food for human consumption and follow relevant regulations for human food are exempt from further regulation for their reuse of animal food. [111]

In addition to the FSMA, the SHPA and Ruminant Feed Ban Rule provide additional considerations when reusing discarded organic materials. Under SHPA, food scraps fed to swine containing animal meat or animal by-products must be heat treated at boiling temperature (212° F or 100° C at sea level) for at least 30 minutes by a person who holds a valid license or permit to treat food scraps. The Ruminant Feed Ban Rule bans the use of mammalian protein as feed in all ruminant animals (e.g., cows, sheep, goats, deer, elk, and antelopes).[112]

Based on these regulations and the current conditions within the USVI, there appears to be a market for the reuse of spent grains at breweries as animal feed. In 2018, the U.S. agricultural census estimated that 234 farms in the USVI purchased animal feed for livestock.[113] Currently, there are at least five breweries in the USVI producing various quantities of beer. As noted in Chapter 1, a number of these breweries, such as Brew STX, already send their spent grains to local farms as animal feed.

ANIMAL FEED – TECHNICAL CONSIDERATIONS

The reuse of discarded organic materials as animal feed may require some investments for the safe treatment, storage, and shipment of feed depending on the type produced. The reuse of spent grains require minimal investments for shipment and storage equipment. Because breweries produce products intended for human consumption, spent grain produced as a by-product during the brewing process is exempt from additional regulation under SHPA. Thus, there will be no investments needed for further

[110] Asian Development Bank, 2014a.

[111] ReFED, 2021.

[112] ReFED, 2021.

[113] U.S. Department of Agriculture, 2020.

treatment or refining of spent grain within the USVI. To ship grains to local farms, farmers require a vehicle large enough to transport their shipment of grain to their farms. Once the spent grain is transported to farms, farmers may need a storage area to house the grain that is not immediately used for animal feed.

EXHIBIT 2-13. ANIMAL FEED TECHNICAL CONSIDERATIONS

	ANIMAL FEED TECHNICAL CONSIDERATIONS
Land Requirements	None
Heavy Equipment Requirements	• A truck or vehicle large enough to transport spent grain from the brewery to farm. • If necessary, a storage container to store spent grains not used immediately.
Resilience Requirements	None

ANIMAL FEED – ECONOMIC CONSIDERATIONS

The reuse of organic materials as animal feed will likely create a minimal economic impact. For spent grains specifically, the main cost burden will be borne from transportation costs. Farmers who do not have an adequate vehicle, likely a pick-up truck, to transport the spent grains from the brewery to their farms, will have to purchase one. In 2019, the national average price for a new pick-up truck was $49,888.[114] Transportation costs will also include gasoline and maintenance costs. The average per gallon price for gas in the USVI is $3.21.[115] AAA estimates that the average annual cost of car maintenance in the US is $792.[116] There may also be costs associated with the storage of spent grains on farms, but these costs are expected to be minimal.

Although the reuse of spent grains may create costs for farmers, there are also expected cost savings. In 2018, farmers on the USVI spent $777,689 on animal feed or $3,323 per farm. As more spent grains are reused, the total cost of feed for farmers in the USVI will decrease.

EXHIBIT 2-14. ANIMAL FEED ECONOMIC CONSIDERATIONS

	ANIMAL FEED ECONOMIC CONSIDERATIONS
Jobs Created	None
Capital Costs	$49,888 – per new pick-up truck
Operating/ Maintenance Costs	$3.31 a gallon for the quantity of gas used. $792 annually for maintenance.
Effects on Import Costs	May offset costs ($777,689) associated with importing animal feed
Effects on Export Costs	None

[114] Edmunds, 2020.

[115] Numbeo, 2021.

[116] AAA Automotive.

2.8 CONTAINER REUSE AND RECYCLING

CONTAINER REUSE AND RECYCLING

Container reuse for both glass and metals provides an avenue for potential reductions in the associated material streams. This is primarily relevant in the commercial sector, where hotels, breweries, and restaurants rely on single-use beverage containers for convenience. Hotels, breweries, and restaurants could focus on the direct-to-consumer sale of beverages in reusable containers, such as growlers, and glass bottles, and "take back" these containers for refill and reuse.

For instance, several breweries in Honolulu allow for customers to put down a deposit for a growler (ranging anywhere from $3 to $20 for containers ranging in size from 32 oz and 64 oz) and will refill growlers with any brewed beverages on tap. Customers receive their deposit back once they return the growler.[117]

Policies such as beverage container deposit programs, also known as "bottle bills", can help to motivate and encourage a robust culture of container reuse. Beverage container deposit programs require a minimum refundable deposit on beer, soft drink, and other beverage containers to ensure a high rate of recycling or reuse. This deposit is refunded when containers are returned for recycling or reuse.

Deposit programs can be instituted territory-wide or at a smaller scale by individual breweries in the USVI, assuming they have the capacity and equipment to collect and wash their bottles. Some islands, including the Barbados, Fiji, Palau, Kiribati, Iceland, Seychelles, Scotland, Hawaii, and the Federated States of Micronesia have developed bottle deposit systems to reduce litter and increase container recycling and reuse.[118] For instance, since 2005, Hawaii's deposit beverage container program has led to the reuse and recycling of over 7 billion containers.[119] Deposit amounts in the U.S. range from two cents to 15 cents. Ten states have implemented deposit programs, which have been effective in increasing recycling rates. Depending on the deposit value, **recycling rates for beverage containers range from 65 percent to 95 percent in deposit states, while beverage container recycling rates in non-deposit states average 30 percent.[120]**

The implementation of programs and policies to motivate container reuse requires technical and economic considerations, which are discussed in more detail below.

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[117] Ellis, 2018.

[118] Container Recycling Institute, 2021a.

[119] State of Hawaii, 2021a.

[120] Gitlitz and Franklin, 2006.

CONTAINER REUSE AND RECYCLING – TECHNICAL CONSIDERATIONS

Washing reusable containers instead of relying on disposable containers adds a layer of effort to a restaurant seeking to reduce single-use beverage use. Restaurants will need to reconsider systems for food and beverage distribution to account for this change. The installation of sanitizing equipment and a dishwasher at hotels and restaurants that do not already have one can increase the ease with which this transition takes place without impacting kitchen efficiency. Both land requirements and resilience requirements for container reuse are minimal.

Policies that can support container reuse and recycling, such as container deposit programs, require redemption locations, where customers can receive their deposit. These redemption locations can be sited as an individual facility or integrated within facilities where beverages are sold (e.g., supermarkets, liquor stores) While not necessary, deposit return machines can be installed to facilitate the rapid sorting and efficient distribution of deposits. Deposit return machines are typically compact, at one square meter.[121]

EXHIBIT 2-15. CONTAINER REUSE AND RECYCLING – TECHNICAL CONSIDERATIONS

	CONTAINER REUSE AND RECYCLING TECHNICAL CONSIDERATIONS
Land Requirements	Minimal
Heavy Equipment Requirements	Additional dishwashing equipment and deposit return machines
Resilience Requirements	Minimal

CONTAINER REUSE AND RECYCLING – ECONOMIC CONSIDERATIONS

The installation of a dishwasher or dedicated container washer at hotels and restaurants that do not already have one can increase the ease with which reusable containers are used. The resulting effect on employment is likely minimal as existing kitchen staff can be used to load the dishwasher. Obtaining a commercial dishwasher can cost anywhere from $3,000 to $25,000 per dishwasher, depending on scale.[122] Operating and maintenance costs range from $600 to $1,200 annually, depending on the energy and water use efficiency of the dishwasher in consideration.[123]

The implementation of a container deposit program does not require any heavy equipment but deposit return machines can be installed to facilitate the rapid sorting and efficient distribution of deposits; these machines cost between $10,000 to $25,000 each and cost around $0.0391 per container returned.[124,125] The implementation of such a program has the potential to create jobs in retail, distribution, and recycling. For instance, Maine's container deposit program is estimated to have created 626 jobs.[126] In

[121] Tomra.

[122] Active Element.

[123] U.S. Department of Energy Office of Energy Efficiency & Renewable Energy.

[124] Wu, 2004.

[125] Reclay StewardEdge Inc., 2014.

[126] Container Recycling Institute, 2021b.

addition, container deposit programs have the potential to generate revenue for the government. In 2017, unclaimed deposits amounted to approximately $110.6 million in New York, $45.5 million in Massachusetts, $33.8 million in Michigan, and $34 million in Connecticut; the funds were used to fund statewide environmental initiatives.[127]

The effect on import costs depends on the scale at which glass and metal use and disposal rates are reduced. The USVI imports $6 million in beer annually; some of these costs could be reduced by relying on kegs rather than single-use containers, which are more volume intensive.

EXHIBIT 2-16. CONTAINER REUSE AND RECYCLING - ECONOMIC CONSIDERATIONS

	CONTAINER REUSE AND RECYCLING ECONOMIC CONSIDERATIONS
Jobs Created	Minimal (with the potential to create ~50 jobs under a container deposit program)
Capital Costs	Ranges from $3,000 to $25,000 per dishwasher (and $10,000 to $25,000 per deposit return machine)
Operating/ Maintenance Costs	Ranges from $600 to $1,200 annually per dishwasher (and $0.0391 per container returned under a container deposit program)
Effects on Import Costs	USVI imports $6 million in beer annually, some of which might be decreased by relying on kegs instead of single-use bottles and cans

[127] Container Recycling Institute, 2021c.

2.9 PLASTICS REDUCTION AND RECYCLING

PLASTICS REDUCTION AND RECYCLING

Plastics use can be prevented and reduced through a series of materials management policies. Aligned with the USVI's current plastic bag ban and plastic straw ban, the USVI could explore banning other popular, single-use plastics products, such as bottled water. Cities, such as San Francisco, Los Angeles, Salt Lake City, Miami, Chicago, and Chapel Hill, have banned the sale of bottled water, saving municipalities in landfilling costs. For instance, Bundanoon, a city in Australia banned the commercial sale of bottled water in 2009, resulting in $2.5 million in avoided landfill costs.[128] Instead, tourists and residents are encouraged to refill their water bottles in water foundations around the town.

Other island nations are also exploring the use of policy to curb the use of other single-use plastics such as food containers and cups. For instance, Samoa banned single-use plastic bags and straws in 2019 and plans to ban Styrofoam food containers and cups once environmentally friendly options are identified.[129] As another example, Trinidad and Tobago signed an agreement with the Organization of American States to evaluate the design and development of sustainable, biodegradable packaging as an alternative to Styrofoam packaging.[130] Private companies are rapidly expanding in this space to address market needs for reusable foodware. For instance, Caribe Compostables, based in Puerto Rico, is a company that offers compostable products to replace single-use plastics and Styrofoam for restaurants, cafeterias, and other food vendors in the Caribbean and U.S.[131]

In addition to using policy to curb discarded plastics, recycling emerges as a viable opportunity as well. Recycling is the process of mechanically or chemically transforming plastic materials into new materials or products. While it is technically possible to recycle most plastics in the USVI (i.e., PET, natural and colored HDPE, mixed and bulky rigids, plastic film, and EPS), small-scale plastics recycling collection for export efforts on islands have not been shown to be viable. There are some recycling programs in the USVI run by volunteers or micro-enterprises, such as The Market Grocery Store Recycling Campaign. However, these programs, which rely on exporting plastics to facilities in the Caribbean or the mainland, often run at a loss.

Instead, the USVI could consider innovative means to recycle plastics on island. For instance, in Kenya, there is a micro-enterprise that collects high density polyethylene (plastic used for milk and shampoo bottles), low density polyethylene (plastic used in cereal and sandwich bags), and polypropylene (plastic used for ropes, lids, and buckets). The collected plastic is mixed with sand, heated, and then compressed

[128] Goldsmith, 2009.

[129] Samoa Observer, 2018.

[130] Organization of American States, 2014.

[131] Caribe Compostables.

into bricks, which is almost five to seven time stronger than concrete, and sold for $7.70 per square meter. Since its founding in 2017, this organization has recycled 20 tons of plastic and produces about 1,500 bricks each day.[132]

In a similar application, a builder in Kauai, Hawaii utilized discarded plastic on beaches to create construction blocks to build an athletic pavilion at the Island School in Lihue. This project used the ByFusion Blocker, a machine that compresses post-consumer plastics into construction blocks that can be used to build retaining walls, sound walls, sheds, privacy fencing, terracing and landscaping, accent walls, and furniture. In this particular project in Kauai, the project along utilized 2.4 tons of discarded plastic.[133] ByFusion's Community Blocker, designed for smaller recycling operations, processes up to 30 tons per month and has modular installation.[134]

There are also several microenterprises using low temperature extrusion to recycle post-consumer plastic on a small scale to create usable products. In the British Virgin Islands (BVI), VI Plastics is a microenterprise that recycles plastics collected in the BVI to create outdoor furniture and utility products. In addition to producing furniture, VI Plastics partners with a local organization, Green VI, to create recycling receptacles for the island.[135] In Hawaii, a microenterprise called Upcycle Hawaii processes plastics and other materials that are landfilled to create art, jewelry, and other lifestyle products.[136]

Lastly, organizations and companies, such as the Plastic Collective and Precious Plastic, are encouraging small-scale recycling microenterprises by helping communities gain the knowledge and equipment to do so. Plastic Collective focuses on supporting remote communities, such as Mantanani Island in Malaysia, Atauro Island in Timor-Leste, and Gizo in the Solomon Islands, by providing machinery and training to establish plastics recycling. In particular, they rely on the "Shruder" recycling machine, which is a portable unit that integrates a shredder and extruder and can shred five kg of plastic an hour.[137] Precious Plastic offers open source information and machinery for communities to start their own plastics recycling microenterprises and has inspired several offshoots globally, including Precious Plastic Fiji, Big Island Precious Plastic (Hawaii), and Precious Plastic Bangkok. [138]

PLASTICS REDUCTION AND RECYCLING – TECHNICAL CONSIDERATIONS

To facilitate compliance and acceptance of single-use plastic bans, the USVI would have to integrate the proper infrastructure and systems. For instance, installing hydration/bottle refilling station would help facilitate compliance with a bottled water ban. The stations could be installed, by a licensed plumber, in any public building in prime tourist locations. These stations are typically wall-mounted and do not

[132] Waita, 2021.

[133] Powell, 2020.

[134] ByFusion, 2020.

[135] VI Plastics, 2020.

[136] Upcycle Hawaii, 2020.

[137] Plastic Collective, 2020.

[138] Precious Plastic.

require much space (a typical bottle refilling station is 38 inches in height, 18 inches in length, and 19 inches in width).[139]

Similar to single-use plastic bans, facilitating microenterprises that utilize post-consumer plastic would require that the USVI encourage entrepreneurship, especially on a small scale. There are some technical requirements that should be considered when implementing these plastic recycling microenterprises. Plastic shredders that can process 50 kg of plastic per hour or extruders that can mold 20 kg of plastic per hour can be around 5 feet in length, 2 feet in width, and 5 feet in height.[140] Additionally, a plastic shredding or extrusion operation would require trucks to collect and haul plastics used as feedstock. Microenterprises would require enough land to fit shredding and extrusion equipment, as well as store plastic feedstock.

EXHIBIT 2-17. PLASTICS REDUCTION AND RECYCLING TECHNICAL CONSIDERATIONS

	PLASTICS REDUCTION TECHNICAL CONSIDERATIONS	PLASTICS RECYCLING TECHNICAL CONSIDERATIONS
Land Requirements	• Minimal; bottle-filling stations could be installed in existing buildings/infrastructure	• Minimal and flexible; enough space to fit: ○ Some small equipment; at least 5" 2" 5" (length x width x height) ○ Plastic collection areas (some already exist)
Heavy Equipment Requirements	None	• Trucks to collect and haul discarded plastics • Sorting and processing equipment • Shredder or extruders
Resilience Requirements	Equipment should be stored in areas that are protected from flying debris	Equipment should be stored in areas that are protected from flying debris

PLASTICS REDUCTION AND RECYCLING – ECONOMIC CONSIDERATIONS

In terms of economic considerations, the average cost to install a bottle-filling station ranges from $4,000 to $4,500 and average annual maintenance costs range between $600 to $650 per year.[141] Installing bottle-filling stations would rely on existing jobs in the USVI, such as plumbers. For plastics recycling,

the upfront costs to start a plastics recycling microenterprise are around $14,000, which would include the cost of space and equipment. Annual operating/maintenance costs can be up to $72,000 to cover the cost of renting space for a workshop, materials, and wages.[142] A microenterprise of this scale could create up to three jobs.[143]

[139] Global Industrial, 2021.

[140] Precious Plastic.

[141] Penn State Sustainability Institute, 2020.

[142] Precious Plastic, 2020.

[143] U.S. Environmental Protection Agency, 2020b.

Bottle-filling stations and plastics recycling microenterprises can replace a portion of the amount spent on importing plastic water bottles, as well as plastic furniture, construction materials, jewelry, and other plastic items. Exporting discarded plastic for landfilling could cost the USVI $6.3 million annually.[144]

EXHIBIT 2-18. PLASTICS REDUCTION AND RECYCLING ECONOMIC CONSIDERATIONS

	PLASTICS REDUCTION ECONOMIC CONSIDERATIONS	PLASTICS RECYCLING ECONOMIC CONSIDERATIONS
Jobs Created	Varies depending on the scale of the program	Up to 3 jobs
Capital Costs	$4,000 to $4,500 (per bottle- filling station)	$14,000 (cost of equipment and space)
Operating/ Maintenance Costs	$600 to $650 per year (per bottle-filling station)	$72,000 per year (cost of rent, materials, and wages)
Effects on Import Costs	Bottle-filling stations can replace a portion of the amount spent importing plastic water bottles.	Recycled plastic products can replace a portion of the amount spent importing plastic furniture, construction materials, jewelry, and other plastic items.
Effects on Export Costs	Exporting plastic waste for landfilling could cost $6.3 million annually	

[144] Carlson, 2019.

2.10 TIRE RECYCLING

TIRE RECYCLING

Tires present a difficult waste management problem as they are currently stored in large quantities in the USVI. While the USVI has worked to reduce the stock of used tires in the territory by shipping them to the mainland, an estimated 196,000 tires remain currently stored at USVI landfills. [145] This storage takes up space and poses risks, such as tire fires and mosquito breeding from standing water collection.[146] Through the processing of tires into new forms, some of these hazards can be reduced. In the USVI context, tires can be simply processed by baling. Baling involves the crushing and binding together of multiple tires into larger forms, often cube- or rectangular-shaped. This removes excess air volume from the tires, reducing their total size, while also creating a form viable for use in some construction applications.

As an example, Saipan in the Mariana Islands implemented a baling program for tires. The Department of Public Works uses a heavy-duty baler to create bales of 100 tires, weighing about a ton. The baled tires are then covered with chicken wire and spayed with gunite to create wall, fencing, and barrier structures around its landfill.[147]

Tire retreading also poses an opportunity to repurpose discarded tires in salvageable condition for continued use within the USVI, negating the need for the purchase of new tires. In retreading, tires near the end of their typical usable life are inspected for stability and fitted with new treads and then resold, preventing their immediate landfilling. The industry consensus is that well-maintained retreaded tires have equivalent reliability to well-maintained newly manufactured tires.[148,149,150]

Tire retreading is a popular option in countries around the world, such as the Dominican Republic and Jamaica, particularly among truck fleets and in other commercial applications where cost control is a

[145] Lee, 2020.

[146] U.S. Environmental Protection Agency Archive, 2016.

[147] Harder, 2020.

[148] Tire Retread & Repair Information Bureau, 2020.

[149] Daystar et al., 2018.

[150] Bozarth, 2001.

priority. [151,152] The U.S. certifies tire retreading facilities, and today much of the process can be automated.[153]

The USVI can use policy to encourage tire recycling. For instance, tire landfill bans have been used to divert this material from landfills and towards recycling. For instance, Puerto Rico requires recycling of all tires and prohibits their disposal in landfills. Similarly, Guam has banned tire landfilling since 2008.[154] In 2013, Guam's waste management service company, Guahan Waste Control, purchased a tire shredder to dispose of their stockpile of tires. [155] As of 2018, Guam sent about 100 tons of tires per month to South Korea to be recycled.[156]

TIRE RECYCLING - TECHNICAL CONSIDERATIONS

Balers suitable for tires likely already exist at each of the VIWMA landfill and transfer station sites on each island. Tires specific to balers can also be acquired if need be. This equipment has minimal land requirements and can also be portable, negating the need for transport of tire storage to a baling site.[157] Tire bales used in construction typically measure 50" by 40" by 30" and weigh approximately one ton. The resulting bales' most appropriate construction applications are for the building of short retaining walls and as use as non-structural fill.[158] To meet resilience needs, tire processing equipment should be stored in areas that are protected from flying debris.

Tire retreading involves a full manufacturing operation and would be a new industry for the USVI. Generally, the process involves the following steps: inspection of the used tire for suitability for retread, separation the old tread from the tire casing, buffing and repair of the tire casing as needed, the application of a new layer of rubber called the "cushion" onto the existing casing, reconstruction of the tire with a new tread applied on top of the cushion, a curing process in which tires are stored at high pressure at a specific temperature for the bonding cement to cure, a final inspection step, and any painting or further cleanup of the tire.[159] [160] All tires retreaded in the U.S. must be coded with a Department of Transportation manufacturer's code to trace the tire retread facility in the event of tire failure.[161]Tire retreading has become more automated in recent decades, relying on digital inspection tools and less manual labor. The size of existing operations in the U.S. varies; the smallest independent facilities

[151] Retread Tire Association, 2021a.

[152] Wilson, 2018.

[153] Rohlwing, 2019.

[154] Guam Solid Waste Authority.

[155] Recycling Today Staff, 2013.

[156] Swartz, 2018.

[157] Encore Systems, 2016.

[158] Texas Department of Transportation.

[159] Daystar et al., 2018.

[160] Truck-Drivers-Money-Saving—Tips.com, 2021.

[161] Retread Tire Association, 2021b.

manufacture around 20 retreaded tires each day.[162] An operation in the USVI would likely be on this smaller end of the range. The degree to which tire retread facilities rely on automated equipment as opposed to manual labor varies, and could depend on the availability of equipment and expertise in the USVI.[163]

EXHIBIT 2-19. TIRE RECYCLING TECHNICAL CONSIDERATIONS

	TIRE BALING TECHNICAL CONSIDERATIONS	TIRE RETREADING TECHNICAL CONSIDERATIONS
Land Requirements	• Minimal and flexible; enough outdoor space to fit: ○ Heavy equipment; at least 30' by 14' (width x height) ○ Tire waste collection areas (some already exist)	• Would depend on the scale of the tire retread operation.
Heavy Equipment Requirements	Tire baler (may already exist within the USVI)	At a minimum, a curing chamber and any necessary digital inspection equipment. Computer-controlled machines can also assist in tire reconstruction.
Resilience Requirements	Equipment should be stored in areas that are protected from flying debris	An indoor, weather-shielded manufacturing facility would be necessary.

TIRE RECYCLING - ECONOMIC CONSIDERATIONS

Tire balers cost between $18,000 and $60,000 depending on the size and portability of the system and operating costs for baling average around $5 per ton.[164, 165] Assuming all of the USVI's annual tire production were recycled in this manner, total annual operating costs would range from $1,200 for baling. Assuming the labor requirement for tire processing is similar to other recycling processes, one to two jobs may be necessary to implement this system.[166] Tire dealers charge between $2 and $4 per tire for disposal through shipment to the mainland.[167] This translates to an average total off-territory annual disposal cost of between $360,000 and $730,000 per year, if all tires were required to be shipped to the mainland. Baling tires prior to shipment could reduce these shipment costs, but using tire recycling methods to avoid off-territory shipment entirely results in greater cost savings.

In areas with significant demand for retreaded tires, the industry is economically self-supporting and viable at a variety of scales throughout the U.S., Europe, and the developing world. Traditionally, truck fleets have been the most eager consumers of retreaded tires due to the significant cost savings. In recent years, the size of the tire retread market as a share of the total tire market in the U.S. has declined due to

[162] Daystar et al., 2018.

[163] Rohlwing, 2019.

[164] Phillips, 2001.

[165] Sinobaler Machinery, 2020.

[166] Andela, 2020.

[167] The St. John Source, 2014.

the increased availability of low-cost primary tire imports from China.[168] [169] This effect is likely to be slightly less significant in the USVI, due to the high costs of imports. It is also possible that the costs associated with tire retreading would be slightly higher in the island context.

To the extent that demand for retreaded tires can be established in the USVI, the cost savings may be significant with respect to avoided costs of new imported tires and avoided export of waste tires. As mentioned in the previous section on tire recycling, tire dealers charge between $2 and $4 per tire for disposal through shipment to the mainland.[170] Not all tires are viable for retread, but using an assumption that half of all tires slated for disposal in the USVI could be retreaded, the cost savings from avoided off-territory disposal would range between $180,000 and $365,000 per year, if all tires are required to be shipped to the mainland.

High quality retreaded tires can cost half of what new, high quality tires cost. Assuming an average new tire cost of $200, the annual savings due to purchasing retreaded tires could be as high as $18 million territory-wide, if half of all tires were retreaded. Educational campaigns about the environmental merits and cost savings associated with tire retreading could be helpful in encouraging public adoption.[171]

EXHIBIT 2-20. TIRE RECYCLING ECONOMIC CONSIDERATIONS

	TIRE BALING ECONOMIC CONSIDERATIONS	TIRE RETREADING ECONOMIC CONSIDERATIONS
Jobs Created	1 to 2 jobs created (depending on the size of tire processing system)	Depends on the size of the retread operation.
Capital Costs	$18,000 to $60,000 for tire balers	Depends on the size of the retread operation.
Operating/ Maintenance Costs	$1,200 annually for tire baling	Depends on the size of the retread operation.
Effects on Import Costs	Minimal	As high as $20 million annually, depending on the size of the in-territory retread operation and demand for retreaded tires.
Effects on Export Costs	Export costs for the entire annual tire supply total between $360,000 and $730,000; to the extent that tires can be used in the territory, this cost would be reduced	The cost of importing new tires would be reduced for each tire retreaded within the USVI. Raw materials would still need to be imported.

[168] Tire Review Staff, 2016.

[169] Bozarth, 2001.

[170] The St. John Source, 2014.

[171] Tire Review Staff, 2016.

2.11 C&D REUSE AND RECYCLING

C&D REUSE AND RECYCLING

C&D materials can be reduced in during the design, construction, and deconstruction /demolition stages. U.S. EPA estimates that in the U.S., more than 90 percent of C&D debris is generated through demolition and less than 10 percent is generated during construction.[172] Specific C&D generation phase data for USVI is not available, but could help inform priorities for reducing C&D waste.

In the design phase, buildings can be sited and designed to be resilient to natural disasters, such as siting new development in less vulnerable areas and avoiding building infrastructure in coastal zones.[173] In addition, buildings can be designed to reduce the generation of discarded materials during renovations and repairs and at the end of life though "design for disassembly" or "design for deconstruction" approaches, as summarized in Exhibit 2-21 below.[174] In addition, a C&D waste prevention educational and training program can teach construction workers to address, limit, and manage the primary causes of waste generation during the construction phase. For the demolition stage, deconstruction can limit waste and maximize the reuse of various C&D materials, such as doors, hardware, appliances, fixtures, and insulation for other construction jobs.

This approach to reduce discarded C&D materials is used in other island settings. For instance, the Northeast Recycling Council completed an EPA Region 2 project with the Environmental Finance Center (EFC) at Syracuse University to conduct two C&D Reuse & Recycling Trainings in San Juan and Ponce, Puerto Rico. The trainings were the first C&D reuse and recycling events to be held in Puerto Rico and the registration rate was $185 per person for a day-long training. [175] Efforts to divert C&D materials are already happening in the USVI. Island Green Living recently won a $95,000 grant from the EPA to conduct specialized C&D diversion training and is set to be completed in 2021.[176]

[172] U.S. Environmental Protection Agency, 2020a.

[173] EPA, FEMA Region 9, and the Northern Mariana Islands developed a Guidance Manual for Smart and Safe Growth, which include tips for resilient building design. The manual is available here: https://dcrm.gov.mp/wp-content/uploads/crm/CNMI-SSG-Guidance-Manaul-Final-Double-Sided-Print-2018-11-14.pdf

[174] Guy & Ciarimboli, 2005.

[175] Northeast Recycling Council, 2012a.

[176] Island Green Living Association, 2020.

EXHIBIT 2-21. TEN KEY PRINCIPLES FOR DESIGN FOR DECONSTRUCTION

Ten Key Principles for DfD

1. Document materials and methods for deconstruction. As-built drawings, labeling of connections and materials, and a "deconstruction plan" in the specifications all contribute to efficient disassembly and deconstruction.

2. Select materials using the precautionary principle*. Materials that are chosen with consideration for future impacts and that have high quality will retain value and/or be more feasible for reuse and recycling.

3. Design connections that are accessible. Visually, physically, and ergonomically accessible connections will increase efficiency and avoid requirements for expensive equipment or extensive environmental health and safety protections for workers.

4. Minimize or eliminate chemical connections. Binders, sealers and glues on, or in materials, make them difficult to separate and recycle, and increase the potential for negative human and ecological health impacts from their use.

5. Use bolted, screwed and nailed connections. Using standard and limited palettes of connectors will decrease tool needs, and time and effort to switch between them.

6. Separate mechanical, electrical and plumbing (MEP) systems. Disentangling MEP systems from the assemblies that host them makes it easier to separate components and materials for repair, replacement, reuse and recycling.

7. Design to the worker and labor of separation. Human-scale components or conversely attuning to ease of removal by standard mechanical equipment will decrease labor intensity and increase the ability to incorporate a variety of skill levels.

8. Simplicity of structure and form. Simple open-span structural systems, simple forms, and standard dimensional grids will allow for ease of construction and deconstruction in increments.

9. Interchangeability. Using materials and systems that exhibit principles of modularity, independence, and standardization will facilitate reuse.

10. Safe deconstruction. Allowing for movement and safety of workers, equipment and site access, and ease of materials flow will make renovation and disassembly more economical and reduce risk.

For the C&D materials that cannot be reused, such as concrete, asphalt, and bricks, recycling emerges as an additional method to divert wastes from the landfill. C&D recycling is the process of collecting and processing C&D materials that would otherwise been landfilled and turning them into new and useful products. Recycling can serve as a viable option to divert C&D waste, such as concrete, asphalt, and bricks from the landfill.[177] These materials can be collected then recycled to produce materials such as new asphalt and concrete products, erosion control bedding, retaining walls for shorelines, ground cover (to replace gravel), or foundation for coral to build new reefs.

As an example, Hawaii has a state law that requires the government to use recycled C&D material when possible for road paving projects. It is estimated that 20 to 25 percent of road construction material consists of recycled materials, such as recycled glass and recycled pavement.[178] Hawaii is also home to the Hawaii Materials Recycling company, which collects discarded C&D materials (e.g., concrete, asphalt, rock, dirt, and sand) and recycles these materials to be reused in a partnering construction company, PB Sullivan Construction. The company crushes the collected material and uses it to create an

[177] C&D waste also includes metals, glass, plastics, and organics such as gypsum and wood. These materials can be recycled or composted. Please refer to the metal recycling, glass recycling, plastics recycling, and composting sections to see the technical and economic considerations associated with managing these material types.

[178] TenBruggencate, 2004.

aggregate base for masonry work and wall rock. In 2019, the company collected and recycled 108,690 tons of discarded C&D materials with the help of two full-time employees.[179]

Implementing a C&D recycling program in the USVI could potentially divert around 23,500 tons of waste from the landfill annually, representing 5 percent of the waste stream in the USVI. There is market potential to sell and use the products of C&D recycling as the USVI hosts a number of concrete manufacturing, paving, and masonry businesses in the territory and supports a robust construction industry of about 170 employees.

Policy can be used to encourage sustainable C&D reuse and recycling. For instance, following the sustainable deconstruction training in the USVI, Island Green Living is planning on propose to the USVI legislature an initiative to stipulate that future construction seek to include 15 to 20 percent from demolition or repurposed material.[180] Aligned with this policy, structures built with FEMA funding must contain the highest percentage of recovered materials practicable.[181]

Other green building certification, such as LEED, can be used to motivate C&D material diversion as points are awarded for diverting 50 percent to 75 percent of C&D material.[182] C&D material landfill bans can also be used to divert C&D materials from the landfills towards recovery and reuse. States such as Massachusetts, D.C., and West Virginia have instituted landfill bans for C&D materials.[183] A study in Massachusetts found that the C&D material landfill ban motivated companies to divert and recycle over 90 percent of C&D material.[184]

C&D REUSE AND RECYCLING – TECHNICAL CONSIDERATIONS

A C&D reuse program requires space for require space designated to store and re-distribute (or re-sell) salvaged C&D items. Existing consignment businesses have used 20- or 40-foot shipping containers to store items and have used 1,800 square feet of warehouse space.[185] Reuse centers are easily scalable, enabling them to grow in size and capacity as demand increases.

C&D recycling requires crushing or pulverizing demolition rubble. Industrial crushing equipment, with jaws and large impactors, are used to crush the C&D waste. Once the C&D waste is crushed, it can be:

- recycled onsite as fill, subbase material, or permeable paving/gravel for walkways or driveways; or
- hauled away to be used at another building site or for road construction, placed at waterfronts for erosion control or shore armoring, or placed in oceanic reef habitats as foundation for new reefs; or

[179] Redling, 2020.

[180] Island Green Living Association, 2020.

[181] Federal Emergency Management Agency, 2020.

[182] U.S. Green Building Council, 2021.

[183] Northeast Recycling Council, 2012b.

[184] Recycling Works Massachusetts.

[185] Island Green Living Association, 2019.

- further pulverized if the C&D is to replace virgin materials in concrete, asphalt, and brick manufacturing.

Land requirements for C&D recycling can be significant (around 10 acres) as crushing operations have to be located in an area conducive to safe grinding and screening so that residents are protected from noise and residual dust. For resilience purposes, the equipment should be stored in an area where it can be protected from flying debris.

EXHIBIT 2-22. C&D REUSE AND RECYCLING TECHNICAL CONSIDERATIONS

	C&D REUSE TECHNICAL CONSIDERATIONS	C&D RECYCLING TECHNICAL CONSIDERATIONS
Land Requirements	Minimal; enough land for • storage container and a temporary structure; or • warehouse space to store/sell/distribute items	Around 10 acres to store recycling equipment and allow for safe grinding and screening operations
Heavy Equipment Requirements	20- or 40-foot shipping container to store salvaged items	• Dump trucks to collect and haul C&D waste • Industrial crusher • Secondary impact crusher
Resilience Requirements	Salvaged items should be stored in structures or containers that are protected from flying debris	Equipment should be stored in areas that is protected from flying debris

C&D REUSE AND RECYCLING – ECONOMIC CONSIDERATIONS

Depending on the scale of C&D materials salvaged, a reuse center could cost around $30,000 in capital costs and around $53,000 annual maintenance and operating costs (the bulk of which is allocated to renting space for the center).[186, 187] However, if reuse centers were incorporated in existing space (e.g. VIWMA facilities or bin sites), then the costs would be significantly reduced. Reuse centers can have a positive impact on the economy. Depending on their number and scale, C&D reuse programs could contribute to the USVI's labor force, creating six jobs, mostly for center or store managers and cash register positions.[188, 189] Deconstruction training, such as trainings offered to C&D workers in Puerto Rico, can cost around $185 per person.[190] As the construction industry employs around 170 people, deconstruction training can cost around $31,450 for the USVI.

[186] Hood, 2020.

[187] Profitable Venture Magazine.

[188] Assuming that there is one donation or consignment center on each island and at least one community with repair events on each island.

[189] Hood, 2020, and The Emporiums, 2005-2020.

[190] Northeast Recycling Council, 2012a.

[191] Machinery Trader, 2020.

For recycling, depending on the C&D recycling equipment selected, C&D recycling could cost around $1 million in capital costs and around $500,000 in annual maintenance and operating costs (the bulk of which is allocated for fuel to operate the equipment).[191, 192] While a C&D recycling program would pose some upfront and annual costs, C&D recycling programs have the potential to contribute positively to the economy and serve as a cost-effective method of managing C&D waste. The alternative to recycling is shipping the C&D waste off-island as the landfills are nearing capacity. Exporting C&D waste for landfilling could cost $2.6 million annually based on weight.[193] In addition, a portion of the cost to import gravel, concrete, bricks, and asphalt could be offset by the recycling of C&D materials. Lastly, C&D recycling programs can contribute positively to the USVI's labor force by creating 37 jobs, mostly for skilled equipment operators to operate the heavy equipment used in the recycling process.[194]

EXHIBIT 2-23. C&D REUSE AND RECYCLING ECONOMIC CONSIDERATIONS

	C&D REUSE ECONOMIC CONSIDERATIONS	C&D REYCLING ECONOMIC CONSIDERATIONS
Jobs Created	6 jobs (cash register positions, managers)	37 jobs (e.g., skilled equipment operators)
Capital Costs	Around $61,000 (cost of renting shop space, storage space, marketing, and store equipment; and cost of training employees on deconstruction techniques)	Around $1 million for heavy equipment
Operating/ Maintenance Costs	Around $53,000 annually	Around $500,000 annually (mostly in fuel and maintenance costs)
Effects on Import Costs	A portion of the cost to import gravel, concrete, bricks, and asphalt could be offset by the recycling of C&D materials	
Effects on Export Costs	The alternative of exporting C&D waste for landfilling could cost $2.6 million annually	

[191] Machinery Trader, 2020.

[192] Tana Recycling, 2020.

[193] Carlson, 2019.

[194] U.S. Environmental Protection Agency, 2020b.

2.12 CONSTRUCTED WETLANDS

CONSTRUCTED WETLANDS

Constructed wetlands are an engineered sequence of water bodies designed to filter and treat waterborne pollutants found in sewage, industrial effluent, and storm water runoff. They use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality. Depending on the topography of the wastewater treatment plants in the territory, constructed wetlands can be built to naturally treat wastewater, conferring additional benefits of improved water quality, providing a greenspace for tourists and residents, and serving as a wildlife habitat.

As an example, Taiwan has erected several constructed wetlands to manage its wastewater. The Xinhai Constructed Wetland in Taipei, Taiwan was constructed in 2009 and serves as greenspace with a 4.8 mile walking path in a busy city landscape. Currently, the wetland hosts eight crops that naturally treat its wastewater and serve as an additional food source to native fauna as well as treats wastewater from the surrounding area at a cost 33 times less than the cost to build a new wastewater treatment plant. [195]

Constructing a wetland could potentially treat the 1.6 billion gallons of wastewater currently treated at the USVI's wastewater treatment plants annually. There is potential to incorporate and create a market for the recycled products discussed in this chapter as recycled glass, compost, and recycled C&D can be used as the sand, soil, and gravel, respectively, needed for construction.

CONSTRUCTED WETLANDS – TECHNICAL CONSIDERATIONS

Constructed wetland are comprised of three primary components: an impermeable layer (generally clay), a gravel layer that provides a substrate (i.e., an area that provides nutrients and support) for the root zone, and an above-surface vegetation zone. The impermeable layer prevents infiltration of wastes down into lower aquifers while the gravel layer and root zone are where bioremediation and denitrification take place. Typically, wastewater is either pumped or allowed to naturally flow through the wetland.

Based on the volume of wastewater treated by the USVI's wastewater treatment plants, the USVI would require a total of 72 acres of relatively flat land to treat the territory's wastewater.[196] Because the constructed wetland largely treats the wastewater naturally without human intervention, once the wetland is constructed using bulldozers and excavators, heavy equipment is not typically required to maintain and operate the constructed wetland. To prevent groundwater contamination during heavy storms, a 25-foot buffer of trees, shrubs, and native ground covers, should be added from the maximum water surface elevation.[197] It takes about two weeks after an extreme weather disruption (e.g., hurricane) for a

[195] Yali, 2012.

[196] Noack, 2018.

[197] BF Environmental Consultants, 2006.

constructed wetland to return to its initial nutrient removal efficiency.[198] (In comparison, it takes half that time or less for a wastewater treatment plant to return to its initial efficiency.)

EXHIBIT 2-24. CONSTRUCTED WETLANDS TECHNICAL CONSIDERATIONS

	CONSTRUCTED WETLANDS TECHNICAL CONSIDERATIONS
Land Requirements	72 acres of relatively flat land
Heavy Equipment Requirements	• For construction only: Dump trucks deliver wetland materials (e.g., sand, gravel, soil) and bulldozer and excavator • Heavy equipment is not required for maintenance and operation
Resilience Requirements	A 25-foot buffer of tree, shrubs, and native ground covers from the maximum water surface elevation; requiring two weeks for the system to regain its nutrient removal efficiency

CONSTRUCTED WETLANDS – ECONOMIC CONSIDERATIONS

A constructed wetland could cost between $2.2 million to $4.7 million in capital costs.[199] As a constructed wetland naturally treats the wastewater and only requires the constructed wetland to be inspected around four times a year and after major storms, maintenance costs are lower at $75,000 to $164,000 a year.[200] Occasionally, constructed wetlands require workers to remove invasive species and weed and mulch as needed. Engineering literature indicates that the capital and maintenance costs of a constructed wetland are, on average, 92 percent lower, than that of an equivalent, conventional wastewater treatment plant.[201]

Job creation from constructed wetlands is minimal as they require very little maintenance and given the nature of wastewater, the effects on import and export costs are not applicable. An in-depth economic study would have to be done to compare the costs of treating wastewater at the current treatment plants with that of constructed wetlands to determine cost-effectiveness.

[198] Ho et al., 2018.

[199] BF Environmental Consultants, 2006.

[200] BF Environmental Consultants, 2006.

[201] Ginn, 2016.

EXHIBIT 2-25. CONSTRUCTED WETLANDS ECONOMIC CONSIDERATIONS

	CONSTRUCTED WETLANDS ECONOMIC CONSIDERATIONS
Jobs Created	Minimal as constructed wetlands require very little maintenance
Capital Costs	Ranges from $2.2 million to $4.7 million
Operating/ Maintenance Costs	Ranges from $75,000 to $164,000 annually

SUMMARY OF MATERIAL MANAGEMENT APPROACHES

IEc's research indicates that the identified materials management approaches would require anywhere from 2,500 square feet of land to 72 acres. Some materials management approaches can be implemented without the use of heavy equipment while others require specialized equipment such as an industrial crusher, baler, extruder, front-end loader, etc. With the exception of constructed wetlands, all materials management approaches would require structures (e.g., fencing or buildings) to be constructed to protect valuable components against strong weather events or sited in areas sufficiently distanced from residences and businesses.

Economically, the materials management approaches require $3,000 to $4.7 million in capital costs and incur anywhere from $1,000 to $1 million dollars in operating costs. These material management approaches could contribute positively to the economy by creating 130 to 144 new jobs and offset a portion of costs spent on importing items such as sand, gravel, and fertilizer. As landfills in the USVI are nearing capacity and will soon be unable to accept wastes, the alternative of shipping wastes off-island for landfilling could cost the USVI around $45 million annually.[202] Exhibit 2-27 summarizes the technical and economic considerations of each materials management approach identified for the USVI, along with the aligned policy/program approach that can help to motivate residents and businesses to participate in each materials management effort.

The volume of materials affected by each approach varies widely, with organics and paper representing the highest quantities generated. In addition, enabling policies, equipment, and infrastructure differ across materials. For some materials, simple policy solutions and limited investment in equipment can redirect materials into reuse or recycling processes that can meet existing on-island demand. In other cases, more significant investment in training, infrastructure, and equipment is important to effectively align markets.

Exhibit 2-26 arrays the key materials flows, indicating the size of the flow and the level of equipment and training required to enable materials reuse and recovery, and establish effective secondary materials products and markets. Materials management approaches shaded in dark represent nearer-term areas of focus due, reflecting existing infrastructure and ready markets in the USVI, and limited need for capital investment. Lighter blue shading indicates limited markets on island (a need to consider regional markets) or more significant capital investment and policy alignment.

[202] Carlson, 2019.

EXHIBIT 2-26. INFRASTRUCTURE NEEDS AND QUANTITIES ADDRESSED BY IDENTIFIED MATERIALS MANAGEMENT APPROACHES

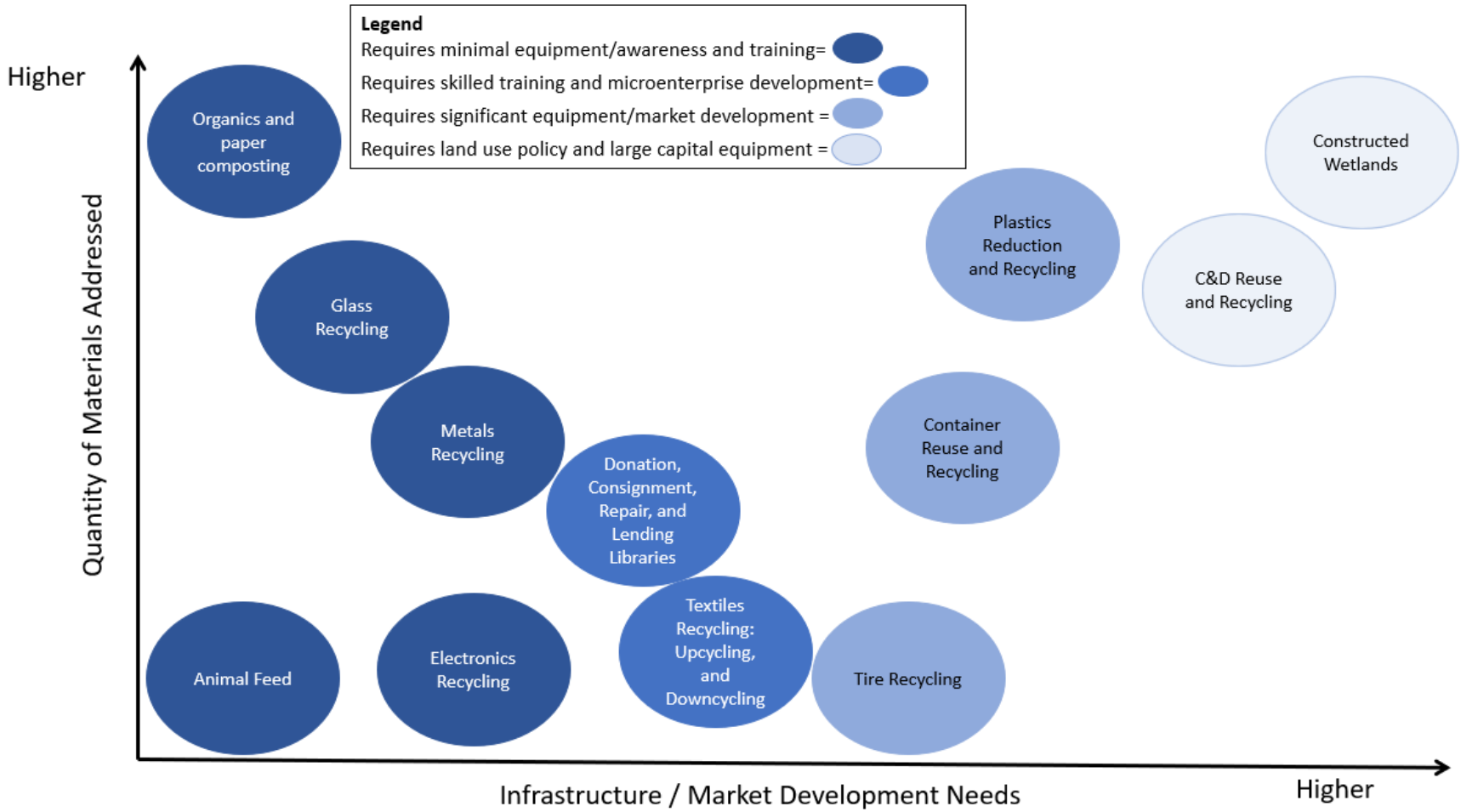


EXHIBIT 2-27. SUMMARY OF TECHNICAL AND ECONOMIC CONSIDERATIONS FOR IDENTIFIED MATERIALS MANAGEMENT APPROACHES

MATERIALS MANAGEMENT APPROACH	ALIGNED POLICY/PROGRAM APPROACH	MATERIAL STREAMS ADDRESSED	LAND REQUIREMENTS	HEAVY EQUIPMENT REQUIREMENTS	RESILIENCE REQUIREMENTS	JOBS CREATED	CAPITAL COSTS	OPERATING/ MAINTENANCE COSTS	EFFECTS ON IMPORT COSTS	EFFECTS ON EXPORT COSTS
Organics and Paper Composting	Organics landfill ban	Organic materials (yard waste, clean wood, food) and paper	Relatively flat land spanning 2 acres to 13 acres	• Garbage/dump trucks to collect organic materials • Brush chipper or a tub grinder to break up waste (e.g., disaster debris) • Magnet and screens • Water source • Front-end loader, bulldozer, compost turner; or composting vessel; or perforated piping	Compost areas should be located at least one foot above seasonal high-water table and 100 feet away from residences and businesses or fencing build around it to protect composting vessels from flying debris	70 jobs (e.g., skilled equipment operators for windrow turners, front-end loaders, and grinders)	Ranges from $300,000 to $600,000	Ranges from $50,000 to $225,000 annually	USVI farms spend $93,000 of fertilizer annually; assuming at least a share of this is imported, domestic composting could offset this cost	Exporting organics for landfilling could cost $16.8 million annually
Glass Recycling	Mandatory recycling	Glass	Up to 2,500 square feet	Glass processing systems, such as those produced by Andela, and glass furnaces for art applications	If stored outdoors, the glass processing system will need to be protected from potential storm debris	2 to 4 jobs created (depending on the size of glass processing system and art operations)	$28,000 to $350,000 (depending on the size of glass processing system) and $10,000 for a glass furnace for art applications	$8,400 to $16,900 (depending on the size of glass processing system) and around $1,000 for power and clean the furnace	The USVI imports sand and gravel from other islands; glass recycling could offset some of those costs	The alternative of exporting glass waste for landfilling could cost $1.9 million annually

MATERIALS MANAGEMENT APPROACH	ALIGNED POLICY/PROGRAM APPROACH	MATERIAL STREAMS ADDRESSED	LAND REQUIREMENTS	HEAVY EQUIPMENT REQUIREMENTS	RESILIENCE REQUIREMENTS	JOBS CREATED	CAPITAL COSTS	OPERATING/ MAINTENANCE COSTS	EFFECTS ON IMPORT COSTS	EFFECTS ON EXPORT COSTS
Metals Recycling	Mandatory recycling	Metals	Minimal and flexible; enough space to fit: • Heavy equipment; at least 10" by 10" (width x height) • Metal waste collection areas (some already exist)	• Dump trucks to collect and haul metal waste • Baler to crush waste • Sorting and processing equipment	Equipment should be stored in areas that are protected from flying debris	Up to 18 jobs (e.g. skilled equipment operators)	$100,000 to $1.5 million (cost of a baler for each island)	$310,000 (mostly fuel and labor costs but market dependent materials value will offset some costs)	None	Exporting metal waste for landfilling could cost $1.7 million annually
Electronics Recycling	Mandatory recycling	Electronics	Minimal; enough space for 40-foot marine containers to store electronics while preparing for shipment	Forklifts (already owned by the VIWMA)	Electronics should be stored indoors or in impervious containers	Limited/based on increased collection beyond current operations	Limited/based on increased collection beyond current operations	Around $82,000 annually (for shipping to a Certified Electronics Recycler)	None	None, already spending approximately $82,000 annually for shipping
Donation, Consignment, Repair, and Lending Libraries	Reuse and repair education and promotion	Bulk, electronics, textiles, and food	Minimal; enough land for storage container and a temporary structure; or warehouse space to store/sell/ distribute items or host repair events and equipment • refrigeration to store perishable food items	None	Items should be stored in structures or containers that are protected from flying debris	6 to 15 jobs (cash register positions, managers, event organizers)	Around $30,000 (cost of renting shop space, storage space, marketing, and storing equipment)	Around $53,000 annually (for rent for donation, consignment, repair, and lending spaces)	A portion of import costs spent on textiles, electronics, food, and bulk items could be offset by donation, consignment, repair, and lending programs	None

MATERIALS MANAGEMENT APPROACH	ALIGNED POLICY/PROGRAM APPROACH	MATERIAL STREAMS ADDRESSED	LAND REQUIREMENTS	HEAVY EQUIPMENT REQUIREMENTS	RESILIENCE REQUIREMENTS	JOBS CREATED	CAPITAL COSTS	OPERATING/ MAINTENANCE COSTS	EFFECTS ON IMPORT COSTS	EFFECTS ON EXPORT COSTS
Textiles Recycling: Upcycling and Downcycling	Reuse education and promotion	Textiles	Minimal; enough space for • hosting textile up/downcycling events • office/store space (if supporting micro-enterprises)	None	None	6 to 9 jobs (mostly for community event organizers, micro-enterprise owners, and skilled tailors)	Minimal; includes cost of • equipment needed to recycle materials (i.e. tools to clean cut, and sew materials) • property (if renting a permanent spot for micro-enterprise or events)	Minimal; includes cost of property rental or event space rental and labor	Recycled textile products can replace a portion of the amount spent importing bags, blankets, and cleaning rags	Exporting textile waste for landfilling could cost $1.3 annually
Animal Feed	Organics landfill ban	Organic materials (spent grains, animal proteins/by-products)	None	Vehicle that can transport grain	None	None	$49,888 - per new pick-up truck	$3.31 a gallon of gas $792 annually for car maintenance	May offset costs ($777,689) associated with importing animal feed	None
Container Reuse and Recycling	Container Deposit Policy	Metal, glass, and plastic containers	Minimal	Additional dishwashing/sanitizing equipment and deposit return machines	Minimal	Minimal (with the potential to create ~50 jobs under a container deposit program)	Ranges from $3,000 to $25,000 per dishwasher (and $10,000 to $25,000 per deposit return machine)	Ranges from $600 to $1,200 annually per dishwasher (and $0.0391 per container returned under a container deposit program)	USVI imports $6 million in beer annually, some of which might be decreased by relying on kegs instead of single-use containers	None

MATERIALS MANAGEMENT APPROACH	ALIGNED POLICY/PROGRAM APPROACH	MATERIAL STREAMS ADDRESSED	LAND REQUIREMENTS	HEAVY EQUIPMENT REQUIREMENTS	RESILIENCE REQUIREMENTS	JOBS CREATED	CAPITAL COSTS	OPERATING/ MAINTENANCE COSTS	EFFECTS ON IMPORT COSTS	EFFECTS ON EXPORT COSTS
Plastic Reduction and Recycling	Materials policy bans (e.g., bottled water ban) and mandatory recycling	Plastics	Minimal	• Trucks to collect and haul discarded plastics • Sorting and processing equipment • Shredder or extruders	Equipment should be stored in areas that are protected from flying debris	Up to 3 jobs	$4,000 to $4,500 per bottle-filling station and $14,000 for cost of equipment and space for recycling	$600 to $650 per year per bottle-filling station and $72,000 per year for recycling	Bottle-filling stations can replace a portion of the amount spent importing plastic water bottles. Recycled plastic products can replace a portion of the amount spent importing plastic furniture, construction materials, jewelry, and other plastic items.	Exporting plastic waste for landfilling could cost $6.3 million annually
Tire Recycling	Tire landfill ban	Tires	Minimal and flexible; enough outdoor space to fit: • Heavy equipment; at least 30' by 14' (width x height • Tire waste collection areas (some already exist)	Tire baler (may already exist within the USVI)	Equipment should be stored in areas that are protected from flying debris	1 to 2 jobs created (depending on the size of tire processing system)	$18,000 to $60,000 for tire balers	$1,200 annually for tire baling	Minimal	Export costs for the entire annual tire supply total between $360,000 and $730,000; to the extent that tires can be used in the territory, this cost would be reduced

MATERIALS MANAGEMENT APPROACH	ALIGNED POLICY/PROGRAM APPROACH	MATERIAL STREAMS ADDRESSED	LAND REQUIREMENTS	HEAVY EQUIPMENT REQUIREMENTS	RESILIENCE REQUIREMENTS	JOBS CREATED	CAPITAL COSTS	OPERATING/ MAINTENANCE COSTS	EFFECTS ON IMPORT COSTS	EFFECTS ON EXPORT COSTS
Construction & Demolition (C&D) Reuse and Recycling	Recycled content requirement for construction and C&D materials landfill ban	C&D	Minimal (for reuse); enough land for • storage container and a temporary structure; or • warehouse or retail space to store or sell/distribute / lend items and around 10 acres for recycling operations	• 20- or 40-foot shipping container to store salvaged items • Dump trucks to collect and haul C&D waste • Industrial crusher • Secondary impact crusher	Salvaged items and equipment should be stored in areas that is protected from flying debris	43 jobs (e.g., cash register positions, managers, skilled equipment operators)	Around $61,000 (cost of renting shop space, storage space, marketing, and store equipment; and cost of training employees on deconstruction techniques) and around $1 million for heavy equipment	Around $53,000 (for rent) and around $500,000 for heavy equipment operation and maintenance	A portion of the cost to import gravel, concrete, bricks, and asphalt could be offset by the recycling of C&D materials	The alternative of exporting C&D waste for landfilling could cost $2.6 million annually
Constructed Wetlands	None identified	Wastewater	72 acres of relatively flat land	• For construction only: Dump trucks deliver wetland materials (e.g., sand, gravel, soil) and bulldozer and excavator Heavy equipment is not required for maintenance and operation	A 25-foot buffer of tree, shrubs, and native ground covers from the maximum water surface elevation; requiring two weeks for the system to regain its nutrient removal efficiency	Minimal as constructed wetlands require very little maintenance	Ranges from $2.2 million to $4.7 million	Ranges from $75,000 to $164,000 annually	None	None

CHAPTER 3 | BARRIERS AND POLICY/PROGRAM RECOMMENDATIONS

Integrating the materials management approaches in the USVI as identified in Chapter 2 requires addressing several barriers to implementation. This chapter identifies the barriers in implementing the materials management approaches as well as the policy and programs that can be used to address these barriers. The barriers can be broadly divided into the following categories and will be discussed in more detail in the following sections:

- Behavioral barriers
- Infrastructural barriers
- Knowledge barriers
- Market barriers

BEHAVIORAL BARRIERS

Transitioning from a landfill disposal waste management approach to one that prioritizes reduction, reuse, recycling, composting, and energy recovery requires a fundamental behavioral shift. At a minimum, residents and businesses are required to change their old habits of disposing all waste in one receptacle and instead, separate waste by designated containers and drop-off points for proper management destinations. The ease of current disposal options is difficult to shift without aligning economic incentives to support behaviors such as sorting.

To support this transition, **an ordinance requiring recycling and source separation**, paired with a **highly visible public Zero Waste or Recycling Goal and an annual transparent measurement program** could be implemented to monitor progress. A Zero Waste Goal would motivate the USVI to design and manage products and processes to systematically avoid and eliminate material discards through conservation and recovery. For instance, following a typhoon in 2013 that resulted in massive piles of waste, Tacloban City in the Philippines committed to implementing Zero Waste goal of diverting 95 percent of its waste from the landfill. Key to the success of such a goal was convincing residents to source separate their waste. Once recycling programs were established in the city, the city passed an ordinance that households must source separate their waste. Failure to abide by the ordinance would prohibit the household from participating in trash collection pick-up services and a fine of $6 per day. Central to these efforts were flyers educating residents on how and what to source separate as well as household visits to show residents that source separation did not have to be an inconvenient or difficult practice. Within one year of implementing the program, the city increased waste diversion from 10 percent in 2017 to 55 percent by the end of 2018.[203] Guam has also made strives to increase recycling through its Zero Waste Goals. In 2020, Guam released research examining the viability of a Greening

[203] https://zerowasteworld.org/wp-content/uploads/Tacloban.pdf

Roadway Infrastructure Initiative under its Zero Waste Plan. This initiative would divert recycled asphalt pavement (RAP), recycled concrete aggregate (RCA), recycled glass, waste tires, and compost from landfills and use these materials in future road construction projects. Similar programs have been successfully implemented in California, Florida, Hawaii, Michigan, Minnesota, Montana, New Jersey, Ohio, Oregon, Texas, Washington, and Wisconsin. [204]

One broader behavioral barrier is a "disposable" economic model that emphasizes one-use materials and one-direction management. To enable an economy that prioritizes reuse and recovery, both residents and business require an overall shift in their approach to all materials, including changes in how they purchase, use, and sell goods to prioritize waste prevention and material reuse. Implementation of **product and packaging ban policies**, such as those for plastic bags, bottles, food containers, and straws, can work to drive residents and businesses to consider alternatives to single-use materials, including reusable bags, bottles, food containers, glasses, and reusable or compostable straws. While the USVI does currently have a ban on plastic bags and straws, this policy is not heavily enforced, disincentivizing businesses and residents to comply. In addition, bulk, refillable products, like cooking oil and detergent, rather than small sachet or single use containers for products could prioritized in island purchasing. **Landfill bans on specific materials** such as organics, C&D, electronic waste, and tires, (as noted in Chapter 2) would also motivate residents and businesses to seek alternative materials management approaches focused on recovery and diversion. As with all policies, it is recommended the USVI ensure that residents and businesses comply with the ban and add additional outreach, enforcement, and penalties if necessary.

Landfill material and packaging bans have been successfully implemented on other islands and in many parts of the world. For example, the Hilo landfill in Hawaii and the Layon landfill in Guam have banned certain materials such as C&D wastes.[205,206] Other islands have sought to ban the use of single-use plastic materials. For instance, Oahu passed legislation in 2019 banning single use plastic bags and most single use plastic utensils, food containers and straws.[207] Other islands like Nantucket, Jamaica, Barbados, Dominican Republic, Grenada, Trinidad and Tobago, and the Bahamas have implemented similar bans.[208,] Any new policies supporting an economy built on reuse and recovery would require appropriate communication, rewards, and penalties to promote a behavioral change to prioritize waste prevention and material reuse.

Another behavioral barrier is the current economic disincentive to consider alternate materials management approaches to landfilling, such as recycling and composting and to source separate materials for more sustainable materials management approaches. Policy and program options that could address this barrier include:

- First, instituting a **landfill tipping fee** or a **pay-as-you-throw fee** program can work that reflect the "true" cost of landfill disposal and provide residents with an understanding of the cost of waste. In

[204] Jacobs Engineering Group, Inc., 2020.

[205] Guam Solid Waste Authority.

[206] Waste360 Staff, 2019.

[207] City and County of Honolulu, 2019.

[208] Yucatan Times, 2019.

pay-as-you-throw programs, fees are typically weight-based and capture the costs associated with the maintenance and operating costs to operate a landfill in compliance with state and federal regulations. The average tipping fee in the U.S. is $55 per ton, while island areas, such as Hawaii, charge higher tipping fees of around $73 per ton.[209] Bermuda charges an even higher tipping fee of $150 per ton.[210] Through internalizing the costs of landfilling through a fee, residents can be incentivized to reduce reliance on landfill disposal through separating items by source and seeking alternative disposal options. The VIWMA is already working on implementing tipping fees for MSW, C&D, green waste, fill waste, and scrap metal at the two landfills in St. Thomas and St. Croix as well as the transfer station on St. John. The tipping fee for general MSW is $52.13 per ton, with the tipping fee for other materials ranging from $31.28 per ton (for fill waste such as soil and sand) and $65.26 per ton (for C&D waste).[211] It is recommended the VIWMA ensure that these tipping fees remain higher than the cost of recycling to incentivize and promote reuse and recovery.

- Second, there are commodity-specific programs and policies that can potentially provide residents and businesses with the motivation to recycle. As discussed in Chapter 2, **container deposit programs** can be used to incentivize consumers to return/recycle glass, metal, and plastic beverage containers by returning deposits to participants.

INFRASTRUCTURE BARRIERS

There is currently very little practice of waste source separation in the USVI. Source separation of waste reduces contamination, supporting the highest and best use of materials while providing a cleaner feedstock for producing recycled materials. However, proper infrastructure is needed to promote source separation and collection.

As the USVI currently primarily relies on landfilling to manage waste, households and businesses lack the proper collection bins to separate their waste. A program to **distribute recycling containers for each commodity of interest** (e.g., a container for electronic waste in offices, a container for metals in residences and offices, and a container for compostable organics and paper in residences and offices) would remove this simple barrier to effective source separation. As an example, Kauai county in Hawaii has offered free backyard compost bins to its residents for nearly 20 years. Kauai's compost program diverts around one ton of excess food a year from entering the island's landfill. The bins cost the county $50 per unit but returns on investment are seen within the first year.[212]

Once containers are distributed, the USVI needs to build on existing infrastructure to collect the various waste materials. Given the current infrastructure of the USVI, collection can likely occur at the curbside, disposal sites, at the landfill, or at the creation of zero waste parks, which are discussed in more detail below:

- At the curbside, the streets are narrow and likely cannot accommodate multiple trucks simultaneously picking up trash and recycling. The **provision of appropriately-sized recycling**

[209] Waste Today Magazine, 2019.

[210] Trott, 2020.

[211] More information available here: https://www.viwma.org/index.php/businessinfo/tipping-fee

[212] Hiraishi, 2020.

receptacles paired with reducing trash collection to every-other-week while instituting weekly collection of recycling and organics can work to promote effective collection and promote recycling. For instance, in the city of Portland, Oregon, the pick-up of garbage every-other-week and weekly collection of recyclables and organics led to a 35 percent reduction in garbage generation and a tripling in the quantity of organics and recyclables collected.[213] Exploring other forms of collection systems could help to facility trash and recycling pick-up. For instance, Tacloban City in the Philippines has very narrow roads that are inaccessible to large dump trucks. To address this, the city used pedicabs, bicycles with a sidecar attached, and plastic drums to collect material discards while simultaneously providing employment opportunities to local residents.[214]

- At disposal sites, collection of source separated materials could be encouraged by having **bins designated for each type of waste** (i.e. organics, plastics, metals, etc.) with information about what can go into each bin. As discussed in Chapter 2, Hawaii has found success in setting up reuse centers at their disposal sites, so residents are encouraged to make a deliberate decision about whether to donate or dispose of their waste.[215] Staffing disposal sites, especially when these recycling and composting programs are first implemented, is another way to encourage effective source separation.
- At the landfill, collection of source separated materials could be promoted by **designating select areas at the landfill (i.e., monofills) to drop off recyclable materials by commodity type**: electronics, metals, paper, plastics, organics, C&D, and tires. Once gathered at the landfill, materials can be baled to reduce volume and maintain material integrity and value. Recycled items can be later harvested once markets have developed and serve as a convenient pick-up location for recycling companies to collect material commodities for further processing. Hauling companies currently operating in the USVI, such as B G Transport, Boynes Trucking System, and O'Neale's Transport, would have to be educated and reconfigure their collection services accordingly to align with materials separation infrastructure and operations.
- **Zero waste parks** can serve as a community space for local recycling collection and composting and reuse. These parks co-locate reuse, recycling and composting processing operations so that businesses and residents can bring their recovered items (e.g., metals, plastics, paper, excess food) to one central location to facilitate collection, reuse, and recovery. In the US, California has several zero waste parks. These parks include Cabazon Resource Recovery Park (Mecca, CA), Monterey Regional Environmental Park (Marina, CA), Urban Ore Resource Recovery Park (Berkeley, CA) and Waste Management, Inc. Resource Recovery Park (San Leandro, CA).[216]

A further infrastructural barrier exists with potential permitting hurdles related to the implementation of new waste management strategies. As the VIWMA or private citizens seek to take advantage of new methods for managing waste, the USVI government could **streamline the permitting process** and work

[213] City of Portland, Oregon, 2018-2020.

[214] Liamzon, 2019.

[215] Hood, 2020.

[216] Liss.

together with the affected entities to resolve potential issues. As an example, a previous citizen attempt to implement a tire shredding program for tire recycling in the USVI never received the valid permits and could not commence operation.[217]

KNOWLEDGE BARRIERS

Repair expertise and knowledge in prevention strategies and reuse opportunities is limited in the USVI. The successful implementation of product consumption prevention and repair and reuse programs requires knowledge of methods to prevent unnecessary consumption and appropriately deconstruct and repair broken items for reuse.

To decrease the knowledge gap associated with product consumption prevention, **educational campaigns** can work to inform residents and businesses of useful strategies to prevent unnecessary consumption or extend the usable life of products through programs such as a lending library. As an example, a knowledge campaign could inform vehicle owners, possibly through a flyer campaign and social media platforms, that actions such as regular rotation and alignment, maintaining correct tire pressure, and driving slowly around curves can work to extend the usable lifespan of tires.

As repair expertise in the territory may be limited, the USVI could provide access to a **subsidized repair workshop, in person or virtually,** to encourage residents to gain knowledge in repair techniques. Repair Cafes, Fixit Clinics, and other organizations have an existing knowledge base and resources that the USVI can leverage as a foundation, to create repair opportunities for its residents.[218] In addition, expertise in materials management approaches, such as composting and C&D deconstruction, may be limited. The USVI could provide access training to encourage residents and businesses to develop these materials management approaches commercially.

While these programs and policies focus on residents and businesses currently residing in the USVI, it is important to note that the territory supports a robust tourist population, many of which may not be familiar with specificities of recycling and material ban policies in the USVI. The tourism department could potentially consider an **education campaign to educate tourists and tourism operators on recycling and product prevention efforts** in the territory so that tourists can prepare for their stay beforehand (e.g., packing a reusable bag to comply with the plastic bag ban, packing a reusable bottle to comply with a single-use bottle ban).

MARKET BARRIERS

Consistent with the limited focus on recycling, the USVI currently has little to no market demand for recycled products. Consumers and producers are not focused on materials management; to support a shift toward recovery and reuse these consumers will need to demand and buy recycled products to encourage the continued practice of recycling and operation of recycling facilities.

Green purchasing and recycled product labeling requirements can work to drive businesses in the USVI to incorporate recycled products in their procurement, creating a local demand for recycled

[217] The St. Croix Source, 2004.

[218] For an example, see here: https://repaircafe.org/en/about/.

products. For instance, Denver Water in Denver, CO requires that property owners of newly constructed areas must purchase and amend their landscaping soil with compost for efficient water retention purchases, creating a local market for compost.[219] The following states have green purchasing requirements for their local agencies: Massachusetts, California, Colorado, Maine, New York, Oregon, South Carolina, Vermont, and Washington. [220]

In line with product labeling requirements, **transparent advanced disposal fees (ADFs)**, product-based fees that are added at the point of sale, can influence consumer and manufacturer behavior towards products with more recycled content or generate less material waste. ADFs can be placed on products that do not use recycled content or can be difficult to recycle, prompting consumers to select products that are made from sustainable materials and that can be diverted from the landfill.[221]

Extended producer responsibility (EPR) policies can also be used to create market incentive for producers to consider sustainable materials management approaches. EPR is a policy approach under which producers are given the responsibility for the treatment or disposal of post-consumer products. Assigning such responsibility provides incentives to prevent wastes at the source, promote product design for the environment, and support recovery and recycling. For example, the Icelandic Recycling Fund creates a fee for producers and importers handling the following materials: motor vehicle waste, paper packaging, plastic packaging, tires, bale plastic, hazardous waste and WEEE.[222] Malta has also implemented EPRs for packaging wastes, vehicles, electrical equipment, and batteries.[223] Commercially, Home Depot has corporate policies where they will take-back and recycle old appliances (e.g., refrigerators, dishwashers, washing machines, etc.). Currently, these items are landfilled in the USVI but an extended producer responsibility would require the company to take-back bulk items and then ship these items back to the mainland for proper cycling. For logistics efficiency, shipping discarded bulk items for recycling can be coordinated with shipment deliveries so that these items can be sent back to the mainland during the same trip.

Green infrastructure and building certification programs can also incentivize homebuilders and construction companies to consider and prioritize the use of recycled materials over materials made from virgin materials, supporting local recycling markets. For example, the LEED certification program instituted by the U.S. Green Building Council requires that at a minimum, 25 percent of building materials must contain 20 percent post-consumer recycled content material or 40 percent post-industrial recycled content material.[224] Such green infrastructure and building policies and programs in the USVI can create a demand and market for recycled C&D materials, such as recycled concrete, in the territory.

Lastly, **green business and certification programs** can also incentivize companies to consider and prioritize sustainable materials management approaches in their daily operations, spurring a demand for

[219] Denver Water, 2020.

[220] National Association of State Procurement Officials, 2021.

[221] Ameripen.

[222] European Environment Agency, 2016.

[223] Malta Environment & Resources Agency.

[224] U.S. Green Building Council, 2020.

recycled commodities. For instance, the Green Restaurant Association provides a certification for restaurants who participate in recycling and composting, use recycled content in the construction of their building, donate excess food, purchase goods in bulk packaging, and offer reusable dishware and cutlery.[225] Designations such as the Ocean Friendly Restaurants program ensure that all participating restaurants do not provide Styrofoam food packaging, abide by proper recycling practices, only use reusable foodware for onsite dining, do not offer plastic bags or to-go containers, and only provide paper straws upon request.[226] Extending beyond restaurant operations, the Hawaii Green Business Program recognizes businesses that strive to operate in an environmentally and socially responsible manner. Its standards for recognition differ by industry (e.g., resorts and hotels, office and retail, restaurant and food service facilities) but generally require participating businesses to recycle and compost where appropriate and forgo the use of single-use items.[227] The British Virgin Islands hosts a Green Certification program that strives to incentivize, guide and educates businesses in best green operation practices. To date, this program has certified 41 businesses, trained 1,505 individuals in green business practices, contributed to the recycling of 3,212 tons of recyclables, and upcycled 17.35 tons of glass and plastic.[228]

SUMMARY

While there are behavioral, infrastructural, knowledge, and market barriers to implementing and operating effective non-landfill materials management approaches, policies and programs can be used to address these barriers in the USVI so that the territory can successfully divert waste from landfills. These barriers and policies and programs are summarized below in Exhibit 3-1.

EXHIBIT 3-1. BARRIERS AND POLICY AND PROGRAM RECOMMENDATIONS TO ADDRESS BARRIERS

BARRIER TYPE	BARRIERS	ASSOCIATED MATERIALS AND MANAGEMENT APPROACHES	EXAMPLE POLICY/PROGRAM TO ADDRESS BARRIERS
Behavioral	Residents and business require a shift in how they purchase, use, and sell goods and there is an economic disincentive to consider alternative materials management approaches to landfilling.	• Applicable to all materials and management approaches	• Establish public zero waste goal and transparent annual measurement program • Landfill tipping fee and/or pay-as-you-throw fee program • Ordinances requiring recycling and source separation
		• Plastics waste prevention	• Implementation of product and packaging ban policies
		• Metal, plastic, and glass beverage containers recycling	• Beverage container deposit programs

[225] Green Restaurant Association.

[226] Surfrider Foundation, 2021.

[227] State of Hawaii, 2021b.

[228] GreenVI, 2019a.

BARRIER TYPE	BARRIERS	ASSOCIATED MATERIALS AND MANAGEMENT APPROACHES	EXAMPLE POLICY/PROGRAM TO ADDRESS BARRIERS
		• Organics, C&D, electronic waste, and tires waste prevention and recycling/ composting	• Material landfill bans • Training programs (e.g., composting and C&D deconstruction)
Infrastructural	There is currently very little practice in source separation in the USVI and for curbside pick-up, streets are narrow and likely cannot accommodate multiple truck simultaneously picking up trash and recycling.	• Applicable to all materials and management approaches	• A program to distribute recycling containers • Creation of zero waste parks • Provision of appropriately sized recycling receptacles paired with every-other-week trash collection and weekly collection of recycling and organics • Designating select areas at the landfill to drop-off recyclable materials by commodity type • Streamlining permitting processes for implementation of new materials management strategies
Knowledge	Repair expertise and knowledge in prevention strategies and reuse opportunities is limited in the USVI.	• Excess food, C&D, textiles, bulk items, and electronics donation and reuse	• Educational campaigns of useful strategies to prevent unnecessary consumption or extend the usable life of products through repair events or lending libraries • Subsidized workshops on repair techniques
		• Excess food, paper, plastics, metals, and glass waste prevention and recycling	• Tourism education campaign on recycling practices and material bans
Market	There is currently little to no demand for recycled products in USVI.	• Plastics prevention and bulk item and electronics recycling	• Product labeling requirements • Green purchasing requirements • Transparent advanced disposal fees Extended producer responsibility
		• C&D waste prevention, reuse, and recycling	• Green infrastructure requirements • Building certification programs
		• Excess food, organics, paper, plastics, metals, and glass waste prevention and recycling	• Green business certification programs

CHAPTER 4 | THE POTENTIAL FOR A CIRCULAR ECONOMY IN THE USVI

The successful implementation of one or more of these approaches can help the USVI build momentum toward formation of a "circular economy." A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the "take-make-waste" linear model, a circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. For instance, in a linear economy:

- natural resources are used to manufacture material goods,
- then these materials are consumed, and
- finally, these materials are disposed of.

In a circular economy:

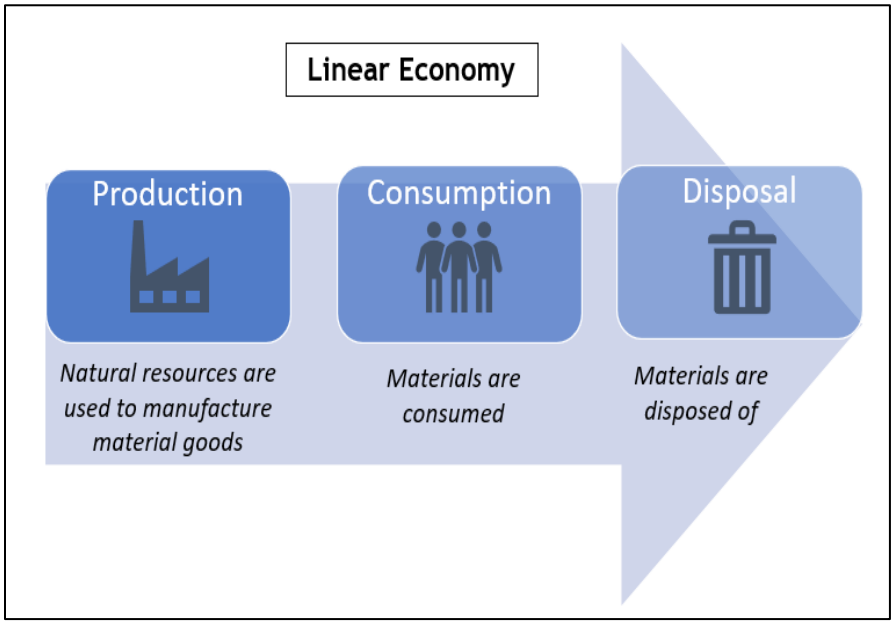
- materials are consumed and reused until they have reached the end of their useful life,
- then these materials are recycled or composted, and
- finally, recycled products are distributed as useful products, replacing the need to use natural resources.

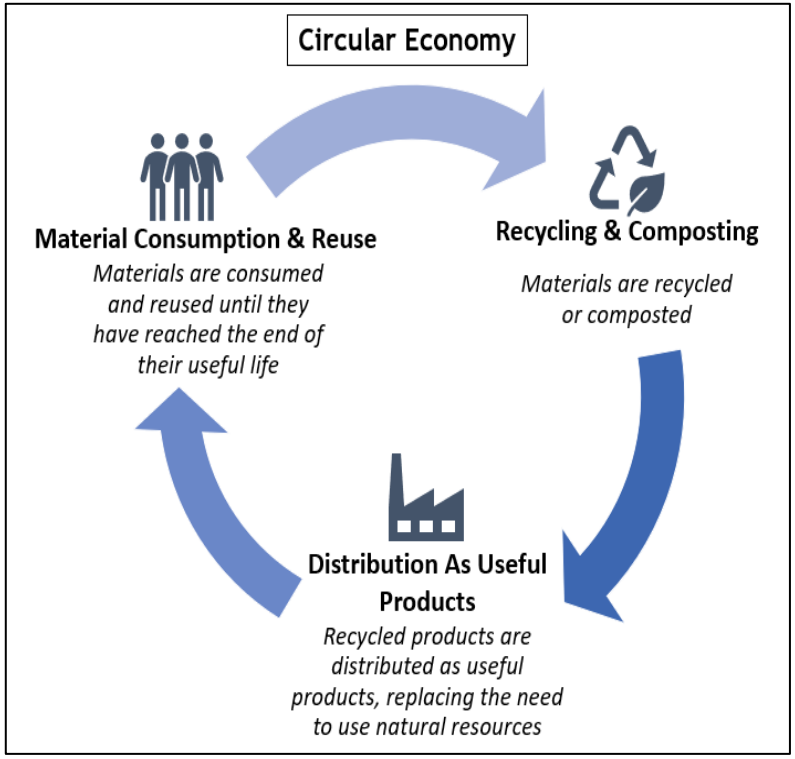
In a circular economy, materials used in production theoretically never reach the disposal stage as they continuously circulate through the economy through manufacturing, use, and recycling. Exhibit 4-1 depicts the contrast between the flow of materials in a linear economy with that in a circular economy.

Materials management approaches and policies that divert materials from landfills and support secondary materials uses represent steps toward building a circular economy. This chapter outlines potential circular economy elements for the USVI organized into the following circular economy stages:

- Material consumption and reuse – to extend product life
- Recycling/composting – to recover materials for use in new products
- Distribution as useful products – to "close the loop" and ensure demand

EXHIBIT 4-1. LINEAR ECONOMY VS CIRCULAR ECONOMY





MATERIAL CONSUMPTION AND REUSE

A functioning circular economy ensures that as products reach their end of life, their materials are reused in the economy through various mechanisms, such as consignment, donation, and repair. These practices, combined with material use prevention programs (e.g., product and packaging bans and waste prevention education programs) aim to move the entire economy away from product disposal.

Focusing on the material management approaches identified as potentially promising for the USVI, material use in a circular economy in the USVI could manifest in the following ways:

- **Elimination of single-use product/packaging waste** (e.g., plastic bags and straws, single-use plastic bottles and food containers) through material bans across the USVI.
- **Recirculation of bulk, electronic, C&D, and textiles** through consignment, donation, repair, and lending libraries to prolong useful life. Existing USVI reuse and consignment facilities (e.g., St. John Eco Station, ReSource Depot, Home Again, Humane Society flea market, Salvation Army thrift shop, Cece's Closet, Animal Shelter Flea Market, The Women's Coalition Consignment Store, and Uniquities) could expand to include bulk items, repaired electronics, salvaged C&D, and textile goods. In particular, USVI policymakers could leverage the prominence of the tourism industry to partner with establishments, such as hotels, to ensure that usable items are donated. Some establishments (e.g., the Westin) already donate some furniture, and would be willing to expand activities as part of a formal program with local organizations and consignment shops.[229]
- **Recovery and redistribution of consumable excess food** to local communities. Hotels, schools, and restaurants could partner with local community organizations, (e.g., the Reformed Church of St. Thomas, Nana Baby Children's Home, My Brother's Workshop in St. Thomas, Helping Hands Food Pantry in St. John, and My Brother's Table in St. Croix) to distribute food to those in need. A robust donation system with established safety and distribution protocols could connect USVI generators such as the grocer CostULess, which does not currently donate excess food but is interested, to accessing a system to divert food. Organizations such as Nana Baby Children's home have demand for fresh produce, and represent potential demand.[230,231]

Taken together, these waste prevention and reuse efforts could divert roughly 28,823 tons of material from the landfill each year (approximately 6.6 percent of discarded materials currently landfilled) and create demand for around 12 to 24 green jobs in the USVI.

RECYCLING AND COMPOSTING

Once materials reach the end of their useful/repairable life in a circular economy, they are then collected for recycling or composting. Recycling and composting in a circular economy in the USVI could manifest as the following:

[229] The Westin St. John Resort Villas, phone conversation, 2021.

[230] Nana Baby Children's Home, phone conversation, 2021.

[231] CostULess, phone conversation, 2021.

- **Generation of compost** by diverting large-volume organics and paper and expanding initiatives such as the Island Green Living composting pilot program, which could serve as a model for eventual composting programs in St. Thomas and St. Croix, as they already have the equipment needed for composting, such as a brush chipper. In addition, to capture large quantities of compostable material with consistent quality, programs could work directly with businesses that generate large volumes of organics, such as hotels, restaurants, and distilling companies (e.g., Leatherback Brewing Company, the Captain Morgan Rum Distillery, Brew STX, and the Cruzan Rum Distillery).
- **Processing of glass discards into secondary materials** such as cullet, ground-glass pozzolan, sand, or for art applications. The USVI could leverage and scale available glass crushing equipment and current glass recycling initiatives on St. Thomas and St. Croix under the oversight of the University of the Virgin Islands. These initiatives can be expanded and serve as a model for an eventual glass recycling program on St. John.
- **Upcycling and downcycling textiles through micro-enterprises** that could use collected textiles in products such as upcycled clothing and reusable bags. Worn textiles that are unable to be upcycled can be downcycled as rags and blankets for local animal shelters.
- **Micro-enterprise plastic waste collection and recycling**. Collection programs such as The Market Grocery Store Recycling Campaign in St. Thomas and Drop-Off Recycling Group in St. Croix could be expanded to facilitate plastics recycling by on-island microenterprises.
- **Uses for old tires** baled to make retaining walls or recycled as retreaded tires.
- **Deconstruction and recovery of C&D materials** for reuse on-island or sale into secondary markets.
- Wastewater would be sent through **constructed wetlands for treatment**.

While an ideal "localized" USVI circular economy would enable recycling and product markets for every material, the technology requirements and economies of scale for some well-developed secondary markets suggest that defining the circular economy more broadly for those materials would be a stronger approach. This is particularly true of metals and electronics. For example, the USVI would collect electronics and metals for shipment and recycling with regional electronics recyclers (e.g., Piranha International Limited in Trinidad and Tobago, or DRE Repair Services in the Dominican Republic) and nearby metals recyclers (e.g., Borniquen Metal Scrap, Homeca Recycling Center, Caribbean Recycling Group Inc. in Puerto Rico). The USVI could also look to partner with shipping companies to save costs on recycling. A representative from Tropical Shipping Company indicated that their company offers preferred shipping rates for certain commodities, and they would be willing to work with the VIWMA to negotiate a discounted price for shipping recyclable materials.[232]

Together these reduction opportunities represent diversion of around 355,870 tons of material from the landfill annually (approximately 82 percent of discarded materials currently landfilled) and creation of around 130 green jobs.

[232] Tropical Shipping Company, phone conversation, 2021.

DISTRIBUTION AS USEFUL PRODUCTS

Once materials are collected and recycled/combusted, a circular economy includes demand for the resulting products. On-island production and distribution of products in a circular economy in the USVI could manifest as:

- **Locally-sourced high-volume construction materials,** saving both landfill space and reducing the cost of acquiring high-volume virgin materials such as gravel, sand, and other aggregate. Recycled C&D products such as concrete, asphalt, and wood could be used as: a gravel substitute for walkways and driveways; road construction fill and base; erosion control, shore armoring, or coral reef foundations; or a substitute for virgin aggregate in concrete, asphalt, and brick manufacturing or combined with glass recycled as ground-glass pozzolan. C&D materials could also be combined with recycled glass as cullet or glass mulch and used as fill or for landscaping. Construction companies (e.g., PSI Tire Supply LLC in St. Croix, Concrete VI in St. Croix, Spartan Concrete Products, LLC in St. Croix, and Heavy Materials LLC in St. Thomas) would purchase recycled C&D products to replace virgin materials in construction materials processing.
- **A sustainable substitute for sand.** Recycled glass as silica has many uses such as golf courses (e.g., Buccaneer Golf Course, Mahogany Run Golf Course, Carambola Golf Club, Reef Club Golf Course), assuming the sand meets the Professional Golf Association's certification standards, and beaches to replace importation of sand. The VIWMA would also purchase the sand for constructed wetlands for natural wastewater treatment.
- **Raw materials for artists and other microenterprises.** Recycled glass might have demand among local craftspeople, and collected plastics from on-island microenterprises would be recycled and formed into furniture, fencing, docks, art, jewelry, and other lifestyle products. Facilitating plastic recycling microenterprises would support small businesses in the USVI while also reducing the need to import certain plastic products. Upcycled textiles as reusable bags would be sold by micro-enterprises to those seeking reusable bags to comply with the plastic bag ban. Downcycled textiles as rags and blankets would be donated to local pet shelters.
- **Soil enhancements for agriculture.** Composted organics and paper could be sold to enhance soil or for engineering purposes such as erosion control. With a total of 9,324 acres, local farms (e.g., Ride to Reef Farm, Hideaway Farm, Sejah Farm of the Virgin Islands) would purchase the compost to offset importation of fertilizer and improve crop yields. Landscaping companies (e.g., LaPlace Landscaping and Maintenance, Island Designs Landscape & Storm Water Solutions LLC, and Cruzan Garden) would purchase the compost to offset importation of soil and fill. Organics, such as spent grains from breweries, would be collected and distributed as animal feed. Should food manufacturing companies become established in the USVI, spent grain can also be delivered to food manufacturing companies to be incorporated into spent grain baked goods. Conversations with breweries, such as Brew STX, noted that they already informally donate their spent grains to farms and would be willing to do so under a formal program.
- **Recycled tires** in the form of retaining walls would be used as structures to divide areas at composting and landfilling facilities to facilitate the separating of materials for recycling collection/composting.

ENABLING POLICIES AND PROGRAMS

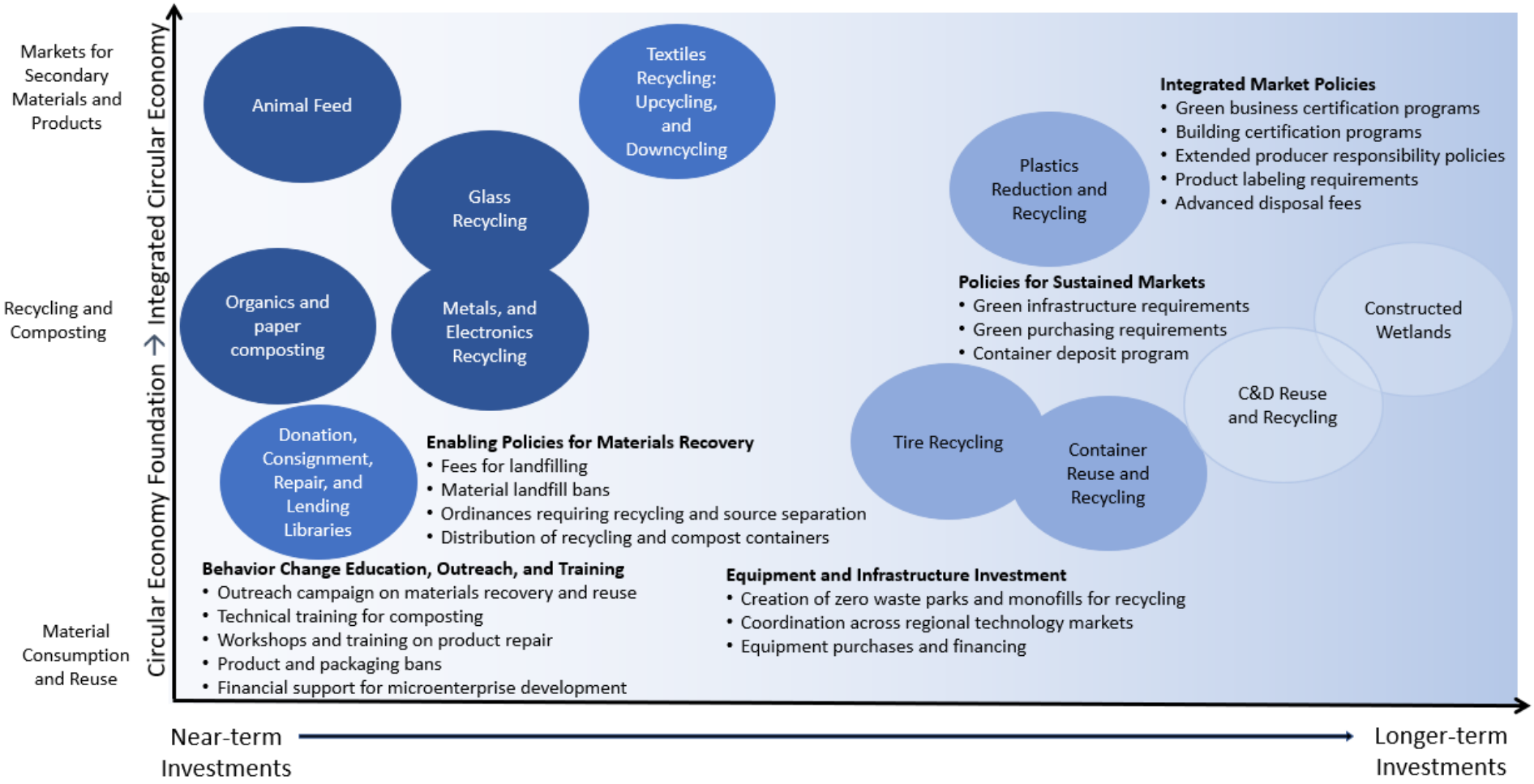
Policies and programs can be used to enable the formation of a circular economy in the USVI. Enabling policies and programs to support material consumption and reuse would include product and packaging bans, as well as educational campaigns to promote reuse, borrowing/lending, and repair. More intensive subsidized workshops on repair would help establish and expand microenterprises focused on supplying local demand. Financial support, such as loans, for interested parties could help to develop microenterprises. More broadly, reuse markets and behaviors would benefit from educational campaigns focused on how to donate food in compliance with USVI food and health standards, and tourism education on territory-wide materials management approaches; these efforts could motivate and encourage a robust culture of waste prevention in USVI's circular economy.

To enable recycling and composting, USVI policymakers could explore the implementation of supporting policies and programs for materials recovery, some of which would require equipment and infrastructure investment. These policies and programs include, but are not limited to, a territory-wide zero waste goal and tracking, landfill tipping fees and/or or pay-as-you-throw fees, ordinances requiring recycling and source separation, collection programs, material (e.g., organics, C&D, electronic waste, and tires) landfill bans, recycling container distribution and recycling collection, and zero waste parks. Technical training on recycling and recovery techniques, such as composting, could also ensure interested parties are trained in the proper techniques for successful implementation. These policies and programs would help to shift incentives away from disposal and toward recycling, composting, and new products.

To enable the distribution of recycling products and commodities as useful products, policies geared towards sustaining and integrating markets could be implemented. Such policies include, but are not limited to a container deposit program, green purchasing requirements, product labeling requirements, transparent advanced disposal fees, extended producer responsibility, green infrastructure requirements, green business certification programs, and green building certification programs. These policies and programs could help spur demand for recycled products and ultimately lead to motivating and encouraging a robust market for recycling and recycled products in the USVI's circular economy.

By implementing landfill diverting and materials management approaches and policies/programs, the USVI can take steps to build a circular economy. A circular economy in the USVI has the potential to expand on existing donation and recycling/composting initiatives in the territory as well as encourage and involve the participation of multiple market actors. Exhibit 4-2 summarizes the materials management approaches, programs, and policies that would support the formation of a circular economy, arranged by circular economy stage and the level of near- and longer-term investment required.

EXHIBIT 4-2. INTEGRATED CIRCULAR ECONOMY TIMELINE FOR MATERIALS MANAGEMENT AND PROGRAM/POLICY APPROACHES



CHAPTER 5 | RECOMMENDATIONS

The USVI faces mounting waste issues and requires sustainable materials management solutions. Of the 433,989 tons of waste generated annually in the territory, a preliminary analysis conducted as part of this study estimates that up to 89 percent of the waste stream can potentially be diverted from the landfill through sustainable materials management approaches such as source reduction and reuse, recycling, and composting, and treatment.

The process of establishing a vibrant circular economy in the USVI requires attention to the specific technical and economic considerations surrounding specific USVI materials markets. It is critical that projects consider the land, equipment, and resilience requirements to cost-effectively operate within the territory, and that enabling policies effectively address the behavioral, infrastructure, knowledge, and market barriers to successful implementation. Reflecting these priorities, the following recommendations outline a series of initial steps that can move the USVI toward an integrated circular economy.

STRATEGIC DIRECTION: IDENTIFY AND PRIORITIZE MATERIALS MANAGEMENT APPROACHES

Because a circular economy by definition involves intersecting activities and markets, it is important to develop a strategic approach that leverages existing resources and momentum within the USVI and also addresses key barriers and challenges. This approach involves three recommended steps:

Identify Priority Materials and Management Approaches

An initial step in this process is prioritizing the materials and management approaches that can be most readily addressed. In establishing priorities, USVI policymakers might consider the materials attributes identified in this report, such as material volume, existing infrastructure, and existing secondary materials markets. Other considerations such as safety, existing partnerships, and visibility/interest to the public may factor into initial decision.

Conduct Technical and Economic Feasibility Assessment for Prioritized Materials

For materials and management approaches determined to be of serious interest, it is recommended the USVI conduct a focused technical and economic assessment, bringing in appropriate expertise (e.g., engineers and market experts) to identify feasible locations in the USVI, identify needed capital investments, training, operating costs, and financing/funding needs arrangements, and evaluate community impacts such as local employment and resource needs (e.g., food insecurity) that might be addressed. The assessment would likely also identify potential barriers to successful implementation and identify policies and programs to address such barriers and ensure success.

In their study, it is recommended the USVI consider the impact of existing and soon-to-be policies. For instance, implementation of a robust excess food donation program may decrease the quantity of discarded food generated, affecting the scale of future composting operations.

While the final priorities must reflect local experts and conditions, this study has identified a set of materials management approaches with possible near-term applicability and impact:

- **Organics and paper composting:** This effort is high volume, addressing 242,417 tons (56 percent) of discarded materials generated in the USVI, requires only modest equipment investment and limited technology, and can build on existing composting efforts in the USVI, such as the Island Green Living composting pilot program. Further, farms and landscapers represent a potential market for compost. Our research indicates that market actors in the USVI are already familiar with the benefits and applications for composting as several farms and breweries are already composting their vegetative residue.
    - In addition to composting, some organic materials, such as spent grain, can be diverted as **animal feed**. Again, this effort would require limited infrastructure or technology investment, and is already in practice in the USVI; several breweries already send their spent grains to local farms as animal feed for chickens and pigs. A formal system to promote sustainable partnerships between generators of animal feed-grade excess food (e.g., breweries) and farms might increase this practice without significant investment.
- **Donation/consignment/repair/lending libraries** could address around 28,823 tons (6.6 percent) of discarded materials generated in the USVI, and could leverage the existing network of donation and consignment facilities in the territory that work with a number of donors. Investment would include a focus on logistics more than technology or capital equipment. A more formal system, however, could facilitate and promote partnerships between reuse facilities and hotels and schools, which typically generate material suitable for resale and reuse (e.g., furniture). For excess food, the USVI could explore creating a formal system to promote food donation between restaurants and stores and local food pantries.
- **Textile upcycling downcycling** has the potential to divert around 11,981 tons (three percent) of materials from the landfill. The USVI could explore market-development for these materials, such as local artists and product designers of both high-end products with re-sale value, such as reusable bags, and downcycled uses as rags and animal bedding.
- **Glass recycling** has the potential to divert around 17,527 tons (four percent) of materials from the landfill. While this approach requires more capital investment, the University of the Virgin Islands recently secured the purchase of give glass crushers for St. Thomas and St. Croix with funding from the Community Foundation of the Virgin Islands and the Ocean Conservancy. These organizations are planning on collecting and recycling glass into glass cullet and sand for landscaping purposes and to make sandbags for hurricane preparation. While these operations have not yet commenced, the USVI could explore partnering with these initiatives to expand glass recycling in the territory.
- **Metals recycling** has the potential to divert around 15,442 tons (3.6 percent) of materials from the landfill. Metals in the USVI is already collected, baled, and shipped off-island by recycling companies in the USVI, such as the VI Recycling Company and Mendez Recycling, and several volunteer-run operations, such as recycling initiatives led by The Market grocery stores. The USVI could explore partnering with these organizations as they already have the initial equipment needed for recycling (e.g., can crushers and balers) and possibly contract with metal

recyclers close to the USVI (e.g., Borniquen Metal Scrap, Procesadora De Metales LLC, Homeca Recycling Center, and Caribbean Recycling Group, Inc.)

- **Electronics recycling** has the potential to divert around 3,210 tons (one percent) of materials from the landfill. Most electronics in the USVI is already collected by the VIWMA and shipped to a certified recycler, ITAD Tech in Peachtree Corners, GA. To the extent that donation and repair efforts outlined above include electronics reuse and repair, the quantity of electronics requiring recycling could decrease. In addition, the VIWMA could consider exploring contracts with closer, certified recyclers, such as Piranha International Limited in Trinidad and Tobago, or DRE Repair Services in the Dominican Republic, which in addition to offering recycling services, hosts a buy-back program on certain electronics such as mobile phones.

Identify and Align Enabling Policies

In tandem with the assessment of priority materials and management approaches, the USVI could explore the programs and policies that would address the existing behavioral, infrastructural, knowledge, and market barriers to implementation. These programs and policies range from broad public awareness campaigns and education efforts to more targeted skills training, to policies that incentivize alternative approaches to landfilling.

Enabling programs and policies are critical to providing the foundation for robust market for sustainable materials management. Exhibits 2-26 and 4-2 above provide an overview of the promising materials management options and related policies and programs identified in this report, aligned with the stages of sustainable materials management market development and with the likely implementation time and resources needed to establish markets of different technical complexity. Materials management approaches shaded in dark represent nearer-term areas of focus due, reflecting existing infrastructure and ready markets in the USVI, and limited need for capital investment. Lighter blue shading indicates limited markets on island (a need to consider regional markets) or more significant capital investment and policy alignment.

INITIAL IMPLEMENTATION: PROVIDE A ROBUST TRAINING AND TRACKING PROGRAM

A critical aspect of a circular economy is creating a culture and an economy that recognizes the value of materials in different stages, and is poised to recover, reuse, and produce goods that the economy needs. Therefore, an initial step in any implementation is effective public education and technical training. Concurrent with this, it is important to track the materials that move in the economy to ensure that policies and markets are functioning well as they become established.

Therefore, once the USVI has prioritized materials, management approaches and accompanying policies/programs, the territory should institute a robust materials diversion training and tracking program. One format for this might build on the experience of Zero Waste communities (e.g., in the Philippines) to provide training for residents and businesses on source separation for target materials. Similarly, haulers and materials managers (e.g., landfill employees) could be trained to manage source-separated materials to prevent contamination and coordinate with or operate material management processing facilities (e.g., glass collected for recycling is not co-mingled with metals and is sent to the appropriate glass recyclers).

To support enabling policies, in particular material bans such as plastics bans, it will be important to notify and work with facilities such as hotels, restaurants, and retail establishments, as well as groups

including residents and tourists, to ensure sufficient awareness of bans and on material alternatives (e.g., reusable bags, reusable food containers, reusable water bottles, etc.) and compliance with policy.

Materials management approaches that require more technical expertise, such as repair and composting, represent an investment in technical education and micro-enterprise. Publicly available free or subsidized workshops/webinars and business assistance in sourcing and operating facilities could enable residents and businesses to become more familiar with and positive about composting on their available land and repairing items on their own.

In line with a robust training effort, it is important to develop a transparent measurement program to track the progress of materials management by material type and management practice. EPA's guidance for state and local governments for MSW can serve as a helpful resource as this has served as a cornerstone of Guam's successful Zero Waste program.[233, 234] Annual reporting, by material type, could be mandatory for recyclers, composters, and landfills. In addition, USVI could explore reviewing import and export and other data sources that could provide additional metrics to consistently track results.

REGIONAL AND SUSTAINABLE CIRCULAR ECONOMY: DEVELOP PARTNERSHIPS WITHIN AND OUTSIDE THE USVI

While the central focus of this report is on opportunities for establishing a circular economy within the USVI, some materials markets and recovery technologies are both well-established and capital-intensive (e.g., metals recovery). In addressing these materials, an expanded regional economy may be the most effective approach.

Therefore, to understand both the USVI-specific issues that affect recovery and recycling of materials, and to help expand materials management efforts in the broader region, the USVI should work to develop partnerships at two levels:

- Primary partnerships with organizations within the territory to provide momentum for establishing a USVI circular economy. On example is the Island Green Living Association that is piloting reuse, recycling, and composting programs.
- Strong regional partnerships with organizations and governments outside the USVI with established recovery and recycling programs and Zero Waste programs. Examples include the Bermuda Ministry of Public Works, the British Virgin Island's WeRecycle program, the Hawaiian Islands, and Guam. These programs can likely offer insight and advice on best practices for instituting a culture of and programs addressing reuse and recovery in an island setting, and, notably, for establishing or accessing existing markets for specific materials that reach beyond the USVI.

One model for these partnerships could be a standing stakeholder group comprised of various industries, residents, and government officials within and outside the USVI, and potentially across the broader surrounding area for materials markets that are more regional. By working to bring about an evolution in public policy, such as implementing landfill tipping fees and green procurement policies, the government

[233] More information available here: https://archive.epa.gov/wastes/conserve/tools/recmeas/web/html/download.html

[234] Guam Environmental Protection Agency, 2014.

can steer the USVI economy toward a circular future. In the same vein, whether the circular economy will work depends largely on consumers. Residents and business would need to change their behavior and purchase and use products with reuse and recyclability in mind. Creating a stakeholder group can help to identify the integration of policy and materials management opportunities within the USVI. A helpful starting point would be to invite the possible circular economy market actors identified in Chapter 4 of this report and work with organizations, such as ReCaribe, to revive efforts to bring together islands in the Caribbean to create economies of scale to recover waste.

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APPENDIX A | MATERIALS MANAGEMENT APPROACHES FOR WASTE STREAMS IN THE USVI

As most of the materials generated in the USVI is landfilled and the landfills in the territory are at or close to reaching capacity, there is a need to identify cost-effective and higher-volume landfill diversion and more sustainable waste materials management approaches. This appendix details the analytical methodology and framework we used to identify materials management approaches then discusses each materials management approach identified for each major waste stream in the USVI.

MATERIALS MANAGEMENT APPROACH METHODOLOGY AND FRAMEWORK

The waste characterization studies indicate that the discarded materials stream in the USVI is primarily composed of the following across all sectors:

- Bulk waste (including furniture and small appliances)
- C&D
- Electronics
- Glass
- Metals (including aluminum and ferrous metals)
- Organics (including excess food, yard waste, lumber waste)
- Biosolids/wastewater
- Paper
- Plastics
- Textiles
- Tires

These waste streams comprise 94 percent of the total materials generated annually in the USVI.[235] To identify materials management approaches for each waste stream, IEc used the EPA waste hierarchy as a guiding framework, as depicted in Exhibit A-1.[236]

[235] The other 6 percent of the total waste stream is comprised of contaminants, residue, and hazardous household waste. Given the difficulty and safety issues involved in reusing and recycling these wastes, IEc did not explore materials management approaches for these waste streams.

[236] U.S. Environmental Protection Agency, 2017a.

EXHIBIT A-1. EPA WASTE HIERARCHY

The EPA waste management hierarchy recognizes that no single waste management approach is suitable for managing all materials and waste streams in all circumstances. The hierarchy ranks the various materials management strategies from most to least environmentally preferred, as listed here:

- **Source reduction and reuse:** Source reduction, also known as waste prevention, means reducing waste at the source, and is the most environmentally preferred strategy. It can take many different forms, including reusing or donating items, buying in bulk, reducing packaging, redesigning products, and reducing toxicity.
- **Recycling and composting:** Recycling is a series of activities that includes collecting used, reused, or unused items that would otherwise be considered waste; sorting and processing the recyclable products into raw materials; and remanufacturing the recycled raw materials into new products. Composting is a method of recycling where organic matter is naturally decomposed to produce a soil enhancer (i.e., compost).
- **Energy recovery:** Energy recovery from waste is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel. Common technologies include mass burn facilities, modular systems, and refused derived fuel systems. Anaerobic digestion and landfill gas recovery are also common technologies.
- **Treatment and disposal:** Treatment and disposal is treating waste to reduce its toxicity and ultimately disposing of it. Landfills are the most common form of waste disposal.

To identify materials management approaches that serve as an alternative to landfill disposal, IEc conducted a comprehensive literature search of academic, industry, and news sources and attended a series of discussions with USVI waste management officials and sustainable materials management experts. As there are many source reduction, reuse, recycling, composting, and energy recovery techniques, IEc focused research efforts on identifying and exploring materials management approaches for the USVI that meet the following criteria:

- A proven track record in successfully operating within an island context,

- Feasibility to operate cost-effectively within the USVI,
- Flexibility to operate at an appropriate scale for the USVI, and
- Ability to work within the USVI's existing infrastructure.

The following sections detail the waste materials management approaches identified for each major waste stream, organized by EPA's waste management hierarchy framework. Note that energy recovery and treatment materials management approaches were not identified for all waste streams. Several sources noted that anaerobic digestion (AD), biofuel production, and waste-to-energy could divert C&D, organic, paper, plastic, and textile waste but these options were not identified as viable alternatives for the USVI for the following reasons:

- In terms of economic feasibility, AD and biofuel facilities require a consistent supply of homogenous feedstock. Changes to the consistency of the feedstock in terms of volume or type negatively impact the production of energy, compromising cost-effectiveness. The nature of requirements needed to operate an AD or biofuel facility cost-effectively does not align well with the varying frequency at which wastes in the USVI are generated (e.g., more waste is generated in the tourist season).[237] Technology in this space is rapidly evolving it is recommended the USVI continue to monitor advances as AD and biofuel can potentially serve as viable options to reduce waste in the future.
- For waste-to-energy, two facilities were proposed in the territory but ultimately not pursued due to local concerns surrounding environmental impacts, air permitting, high capital and operating costs, and the disincentive to recycle.

BULK WASTE

In the USVI, examples of bulk waste are large pieces of furniture, plumbing fixtures, and large appliances. Bulk waste comprises 3.1 percent of the territory's waste stream by weight, with the residential sector generating 28 percent of all bulk waste and the commercial/industrial sector generating the remaining 72 percent. The following sections detail the identified materials management approaches in the USVI for diverting bulk waste from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

There are three opportunities identified to reduce bulk waste in the USVI: donation, consignment, and repair/upcycling.

- **Donating** bulk items in usable condition to organizations and thrift stores is one way to reduce and prevent material discards. A number of thrift stores on the island currently accept donations of usable household items for resale.
- **Consignment stores** similarly will accept secondhand items from people, but unlike a thrift store, consignment models compensate suppliers of items when they are re-sold.

[237] The Caribbean Council, 2017 & Moschini et al., 2012.

- There are also opportunities to reduce bulk waste by creating avenues for **repair and upcycling**. Repairing goods can extend product lifetime and use for their owners. Upcycling, which refers to repairing, refinishing, and repurposing items can give belongings a new use or improved appeal.

RECYCLING

Since bulk items are typically comprised of different materials, direct opportunities to recycle or compost bulk waste are limited. However, bulk waste items can be taken apart to enable certain parts of the items (e.g. metals, lumber, textiles, etc.) to be recycled or composted individually.

CONSTRUCTION AND DEMOLITION

Construction and demolition (C&D) materials are generated when new building and civil-engineering structures are built and when existing buildings and civil-engineering structures are renovated or demolished. C&D materials often contain bulky, heavy materials such as:

- Concrete
- Wood and lumber
- Asphalt
- Gypsum
- Metals
- Bricks
- Glass
- Plastics
- Salvaged building components (e.g., doors, windows, and plumbing fixtures)

C&D materials comprise 5 percent of the discarded materials stream, by weight, in the USVI, with 16 percent of C&D materials originating from the residential sector and the remaining 84 percent from the commercial/industrial sector. U.S. EPA estimates that in the U.S., more than 90 percent of C&D debris is generated through demolition and less than 10 percent is generated during construction.[238] Specific C&D generation phase data for USVI is not available, but could help inform priorities for reducing C&D waste.

The following sections detail the identified materials management approaches in the USVI for diverting C&D materials from landfills, guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

C&D materials can be reduced in during the design, construction, and deconstruction /demolition stages. In the design phase, buildings can be sited and designed to be resilient to natural disasters. In addition, buildings can be designed to reduce the generation of discarded materials during renovations and repairs

[238] U.S. Environmental Protection Agency, 2020a.

and at the end of life though "design for disassembly" or "design for deconstruction" approaches, as summarized in Exhibit A-2 below.[239]

EXHIBIT A-2. TEN KEY PRINCIPLES FOR DESIGN FOR DECONSTRUCTION

Ten Key Principles for DfD

1. Document materials and methods for deconstruction. As-built drawings, labeling of connections and materials, and a "deconstruction plan" in the specifications all contribute to efficient disassembly and deconstruction.

2. Select materials using the precautionary principle*. Materials that are chosen with consideration for future impacts and that have high quality will retain value and/or be more feasible for reuse and recycling.

3. Design connections that are accessible. Visually, physically, and ergonomically accessible connections will increase efficiency and avoid requirements for expensive equipment or extensive environmental health and safety protections for workers.

4. Minimize or eliminate chemical connections. Binders, sealers and glues on, or in materials, make them difficult to separate and recycle, and increase the potential for negative human and ecological health impacts from their use.

5. Use bolted, screwed and nailed connections. Using standard and limited palettes of connectors will decrease tool needs, and time and effort to switch between them.

6. Separate mechanical, electrical and plumbing (MEP) systems. Disentangling MEP systems from the assemblies that host them makes it easier to separate components and materials for repair, replacement, reuse and recycling.

7. Design to the worker and labor of separation. Human-scale components or conversely attuning to ease of removal by standard mechanical equipment will decrease labor intensity and increase the ability to incorporate a variety of skill levels.

8. Simplicity of structure and form. Simple open-span structural systems, simple forms, and standard dimensional grids will allow for ease of construction and deconstruction in increments.

9. Interchangeability. Using materials and systems that exhibit principles of modularity, independence, and standardization will facilitate reuse.

10. Safe deconstruction. Allowing for movement and safety of workers, equipment and site access, and ease of materials flow will make renovation and disassembly more economical and reduce risk.

In the construction stage, C&D materials can occur during several stages of a construction project:

- Design due to incomplete documentation, errors in documentation, and frequent design changes.
- Procurement due to ordering errors and suppliers' errors.
- Materials handling due to transportation damage and poor storage.
- Operation due to measurement error by workers, equipment malfunction, accidents, and incorrect use of materials.

To address this, a **C&D waste prevention educational and training program** can teach construction workers to address, limit, and manage the primary causes of waste generation during the construction phase.

[239] Guy & Ciarimboli, 2005.

For C&D materials generated during the demolition stage, **deconstruction** can be used to limit waste generated. Deconstruction is the process of carefully dismantling buildings to salvage components for reuse and recycling. Some commonly reused C&D materials and applications include:

- Easy-to-remove items like doors, hardware, appliances, bricks, and fixtures. These can be salvaged for donation or used on other construction jobs.
- Wood cutoffs can be used for cripples, lintels, and blocking, eliminating the need to cut full length lumber.
- Excess insulation from exterior walls can be used in interior walls as noise deadening material.

RECYCLING

Many high-volume C&D materials can be **recycled** using methods that save both raw materials and energy, and in an island context can reduce costly imports of heavy raw materials. For instance, concrete, asphalt, and bricks can be recycled into aggregate or new asphalt and concrete products. Finely crushed concrete and asphalt can replace virgin aggregate used in ready-mix concrete and asphalt, respectively. Larger pieces of crushed concrete and brick can be placed along vulnerable stream banks for erosion control, placed along shorelines as retaining walls, or used to replace gravel as a ground cover and mulch. Large pieces of concrete can also be carefully positioned offshore to form the foundation for coral to build new reefs.

ELECTRONICS

In the USVI, examples of electronic or "e-waste" include cell phones, computers, printers, and sound equipment. Electronics make up less than one percent of the waste stream in the USVI by weight, but due to the mixed-material nature of these products, including heavy metals, they cannot safely be landfilled. Residential electronic wastes make up 22 percent of all electronic wastes, with commercial and industrial wastes constituting the remaining 78 percent. The following sections detail identified materials management approaches in the USVI, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

There are three opportunities identified to reduce electronics waste in the USVI:

- **Donating** electronics devices in usable condition to organizations and thrift stores is one way to reduce and prevent waste. There are a number of thrift stores that already exist on the island and accept donations of usable items for resale.
- **Consignment stores** similarly will accept secondhand items from people, but unlike a thrift store, consignment models compensate suppliers of items when they are re-sold.
- There are also opportunities to reduce electronic waste by creating avenues for **repair**. Repairing goods can extend product lifetime and use for their owners. While modern electronics more frequently experience failure due to battery degradation or software problems, hardware can still be repaired in many contexts, particularly for larger devices such as televisions.

RECYCLING

Because electronics cannot be safely landfilled in the USVI, the VIWMA currently collects electronics and ships them outside of the USVI for recycling. Collected electronics waste can be shipped outside of the USVI for recycling as there are electronic waste recycling facilities located relatively close to the USVI (e.g., Puerto Rico).[240] This practice is already employed by the VIWMA, but collection is not currently widespread.

U.S. EPA recommend the use of certified electronics recyclers. Responsible electronics recycling provides important benefits, including:

- Reducing environmental and human health impacts from improper recycling
- Increasing access to quality reusable and refurbished equipment to those who need it
- Reducing energy use and other environmental impacts associated with mining and processing of virgin materials, conserving our limited natural resources

A listing of certified electronics recyclers is available via third-party certification organizations on EPA's website.[241]

GLASS

In the USVI, glass makes up 4 percent of the territory's waste stream by weight. Clear glass is the largest single glass category, followed by brown and mixed glass. Residential use makes up 68 percent of total glass waste, with the commercial/industrial sector constituting the remaining 32 percent. The following sections detail the identified materials management approaches in the USVI for diverting glass from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

Reducing glass in the USVI can take place through behavior changes focused on **reducing use of beverage bottles**, namely in the restaurant, brewery, and tourism sectors. Through prioritizing drink sales in reusable glasses rather than bottles, restaurants can reduce their glass waste. Similarly, USVI's several breweries can focus on the direct-to-consumer sale of beverages in reusable containers such as growlers. There are additional opportunities to reuse single-use bottles by cleaning and sanitizing them as well.

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[240] Due to the high costs of electronics recycling, we do not recommend in-territory electronics recycling in this report. The costs of domestic electronics recycling have continued to rise in the United States and other developed nations, largely due to manufacturers' decreased reliance on more valuable components and materials. Due to the lack of demand for the sort of raw materials that would be produced through recycling within the territory, these outputs, such as precious metals and rare earth minerals, would still need to be exported. While the current electronic waste recycling export program can cost-effectively ship materials to one destination in Florida, recycling within the territory would require shipping byproducts to buyers and still shipping residual electronics waste out of territory for further processing. The shipping costs would likely increase, in addition to the cost of the recycling program. For information is available here: https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=5070 and https://www.usnews.com/news/articles/2016-04-22/the-rising-cost-of-recycling-not-exporting-electronic-waste

[241] More information available here: https://www.epa.gov/smm-electronics/certified-electronics-recyclers#findcertified

RECYCLING

Recycling glass into new bottles is not feasible at a scale relevant to the USVI, due to the associated energy, infrastructure, and glass supply requirements.[242, 243] In addition, the exporting of glass for recycling is not feasible for the USVI due to the high costs associated with glass recycling shipping; shipping glass to an out-of-territory plant for processing would cost an estimated $190 per ton, compared with an estimated $10 per ton sale price of the glass post-processing.[244] However, glass waste can be **recycled** within the USVI and processed into the following usable forms for use as a construction material, specifically cullet, silica sand, and "glassphalt," which are described in more detail below:

- **Cullet** production, or the crushing or pulverizing of glass into various-sized pellets, can facilitate the use of glass as a fill material in construction applications. Cullet can be useful in pipe bedding, embankments, constructed wetlands, and other applications requiring fill materials.
- **Recycled Glass/Silica sand,** another product resulting from the processing of used glass, can serve as a high value product with several potential uses, including in utility beds, constructed wetlands, construction applications, cement mixing, and golf course construction and maintenance (assuming the sand meets the Professional Golf Association's certification standards).

There are additional smaller scale glass on-island glass recycling opportunities, which are described in more detail below:

- A small-scale furnace can melt bottle glass to make 100 percent recycled souvenir suncatchers/decorations, as shown in Exhibit A-3. Tourists could be given recycled glass factory tours and purchase locally designed recycled glass items.
- Glass bottles can be recycled into glass beads for jewelry.[245]

While these products will not consume large quantities of glass, they could provide sustainable small business opportunities and support local artists while providing souvenirs and potentially eco-tours for tourists.

EXHIBIT A-3. VISUAL EXAMPLE OF GLASS SUNCATCHERS

[242] Jacoby, 2019.

[243] Glatsky, 2019.

[244] Janes, 2014.

[245] More information is available here: http://www.recycledglassbeads.org/recycled-glass-beads/

METALS

Discarded metals in the USVI is composed largely of ferrous and aluminum items (e.g. aluminum cans). Metals comprise 3.6 percent of the territory's waste stream by weight, with the residential sector generating 63 percent of all discarded metals and the commercial/industrial sector generating the remaining 37 percent. The following sections detail the identified materials management approaches in the USVI for diverting metals from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

There are two opportunities to reduce metal consumption in the USVI: reducing use of metal beverage cans and deconstructing and reusing metal parts of discarded items.

- **Reducing use of beverage cans** is one way to reduce the discarded metals material stream in the USVI. As a tourist location with several breweries and restaurants, there are a lot of metal cans generated from consumers. Offering options for businesses to use reusable vessels, such as glasses, would reduce the number of metal cans in the waste stream.
- **Dismantling** products to salvage components for reuse and recycling, is another way to reduce metals from mixed material items and retain a high sales value for the metals. Scrap metals can be found in appliances, lighting fixtures, and other items that are typically landfilled. These metals can be reused to repair or build other items, such as appliances, building materials, furnishings, fixtures, and decorative artwork.

RECYCLING

Metals, unlike some other materials, can be recycled without reduction of quality. While different metals have slightly different requirements for recycling processes (e.g. melting temperature), the process is largely the same in that it involves collecting, sorting, shredding, melting, purifying, and then solidifying the metal material to be reused as a raw materials for the production of new products.

Creating a metal recycling facility is likely not feasible for the USVI as metal recycling facilities are capital intensive; estimates find that the first month of operating a recycling facility can cost around $30,000 (assuming that suitable infrastructure or a building already exists).[246] However, shipping metals for recycling may emerge as a reasonable materials management approach for the USVI. Since metals are able to retain quality, metal recyclers are willing to pay anywhere from $100 per ton to $2,000 per ton for recycled metal.[247] In addition, there are metal recycling collectors, such as the V.I. Recycling Company, already operating in the USVI as well as metal recycling options relatively close to and available to the USVI. For instance, Puerto Rico has two metal recycling facilities that can likely accommodate the 15,400 tons of metals generated by the USVI annually.

[246] General Kinematics, 2014.

[247] iScrap App, 2020.

ORGANICS

Discarded organic materials in the USVI is composed of food, yard waste, and clean wood. Organics comprise 35 percent of the territory's waste stream by weight (excluding biosolids) with the residential sector generating 32 percent of all organic material and the commercial/industrial sector generating the remaining 68 percent. The following sections detail the identified materials management approaches in the USVI for diverting organic materials from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

Within the organic waste stream, food has the potential to be reduced through **food donation**. Food pantry/donation programs can provide a reliable method for hotels, schools, health care providers, and restaurants to donate uneaten, edible food, helping to reduce excess food and address issues associated with food insecurity for low-income communities and during times of food system disruptions (i.e., after a hurricane). Excess food, such as spent grains, can also be distributed as animal feed for chickens and pigs.

COMPOSTING

Composting, a natural process of recycling organic material into a rich soil amendment, emerges as a viable option to reduce and manage organic waste in the territory. Composting has the potential to manage multiple organic waste streams, including excess food, yard waste, wood waste (e.g., pallets and lumber), and biosolids.

ENERGY RECOVERY

Anaerobic digestion, or AD, is an emerging method to manage organic material. However, the nature of requirements needed to operate an AD facility cost-effectively does not align well with the varying frequency at which organic materials in the USVI are generated (e.g., more excess food is generated in the tourist season).[248] AD facilities require a consistent supply of homogenous feedstock. Changes to the consistency of the feedstock in terms of volume or type negatively impact the production of energy, compromising cost-effectiveness. Technology in this space is rapidly evolving so it is recommended the USVI continue to monitor advances as AD and biofuel can potentially serve as viable options to reduce waste in the future.

TREATMENT

Of the material types in the organic waste stream, wastewater can be treated in a natural manner through **constructed wetlands**. Constructed wetlands are designed and built similar to natural wetlands. They consist of a shallow depression in the ground with a level bottom. The flow is controlled in constructed wetlands so the water is spread evenly among the wetland plants, allowing natural processes to occur and clean the wastewater efficiently and naturally.

[248] The Caribbean Council, 2017 & Moschini et al., 2012.

PAPER

Paper makes up 21 percent of territory-wide waste by mass in the USVI. Corrugated cardboard makes up over half of this total, followed by mixed paper, office paper, newsprint, and aseptic packaging. The residential sector contributes 36 percent of all discarded paper, with the commercial and industrial sectors constituting the remaining 64 percent. The following sections detail the identified materials management approaches in the USVI for diverting paper from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

Paper can be reduced through two main strategies in the USVI, packaging reduction and electronic recordkeeping:

- **Reducing packaging** paper use can simplify the product transport pathway and reduce paper use. Through reusable shipping containers and/or combining shipments into single packages and reducing waste involved in item protection and storage, the required amount of paper can be reduced.
- Transitions toward **electronic recordkeeping** within businesses can reduce reliance on printing and the use of notebooks, while maintaining robust information systems. Similarly, shifting away from residual use of fax machines toward email can produce similar results.

RECYCLING AND COMPOSTING

There are two identified opportunities to reduce paper waste through recycling and composting in the USVI:

- **Recycling:** Paper is recycled by using large machines to shred the paper into small pieces. The paper is then mixed with water and chemicals and heated. The process of heating this mixture breaks the paper down into fibers, which are then put in another machine for bonding, to create new paper. Development of paper recycling facilities within the territory or shipping paper out of the territory for recycling is likely not feasible due to issues with scale and shipment and market price fluctuations. These factors make paper recycling difficult to fund relative to other locally based options such as composting, which is explained in more detail below.[249, 250] While it is not feasible to recycle paper products on-island, high-value paper products, such as cardboard, can be baled and sold to off-island recycling markets. The Market, a grocery store with locations in St. Thomas and St. Croix,[251] bales and ships discarded carboard from their operations to the mainland, so there are existing programs recycling cardboard off-island. IFCO and Pronatura are companies that offer recycling services in Puerto Rico and might have capacity to accept cardboard from the USVI.[252]

[249] Glatsky, 2019.

[250] Wilson, 2001.

[251] For more information: https://www.themarketvi.com/

[252] For more information: http://ifcopr.com/app/index.html, http://www.pronaturapr.com/

- **Composting**: Shredded paper can make a helpful addition to a variety of composting systems. Most paper types can be composted, aside from papers with excessive amounts of ink kale or gloss, and composting paper requires the careful removal of plastic contaminants (e.g., tape, tabs, etc.).

PLASTICS

Plastics in the USVI is composed of PET, natural and colored HDPE, mixed and bulky rigids, plastic film, and EPS. Plastics comprise 13 percent of the territory's waste stream by weight, with the residential sector generating 47 percent of all plastic waste and the commercial/industrial sector generating the remaining 53 percent. The following sections detail the identified materials management approaches in the USVI for diverting plastics from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

There are several opportunities to reduce discarded plastic. Since the USVI imports all of its goods, reducing plastic in the waste stream would involve importing products with less plastic, or less packaging in general:

- **Banning single-use plastics** is one approach to reducing plastic waste. The USVI already has a plastic bag ban, prohibiting businesses from distributing plastic bags to their customers, but this ban could be expanded to include other disposable, single-use products (e.g. plastic utensils, disposable plastic food service ware, plastic water bottles, etc.).
- **Bulk/refill stores and water refilling stations** are another strategy to reduce plastic waste and encourage reuse of existing containers. Bulk/refill stores, or sections of stores, offer customers the ability to purchase goods, such as personal care products, food, or cleaning materials, in reusable containers.

RECYCLING

Plastics in the USVI can be recycled, however, creating a plastics recycling facility is likely not feasible for the USVI as plastics recycling facilities are capital intensive. There are plastics recycling options relatively close to and available to the USVI. For instance, there are small-scale machinery options available to manipulate (e.g. shred, extrude, or compact) plastics into new products. The USVI could utilize plastic compactors to transform post-consumer plastic into construction blocks, or extruders to build docks or furniture.

TEXTILES

In the USVI, examples of textile are discarded clothing, bedding, curtains, and bags. Textiles comprise three percent of the territory's waste stream by weight, with the residential sector generating 77 percent of all textile waste and the commercial/industrial sector generating the remaining 23 percent. The following sections detail the identified materials management approaches in the USVI for diverting textiles from landfills, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

There are three opportunities identified to reduce textile waste in the USVI: donation, consignment, repair/upcycling, and lending libraries.

- **Donating** textiles in usable condition to organizations and thrift stores is one way to reduce waste. There are a number of thrift stores that already exist on the island and accept donations of usable textile items.
- **Consignment stores** similarly will accept secondhand items from people, but unlike a thrift store, consignment models compensate suppliers of items when they are re-sold.
- There are also opportunities to reduce textile waste by creating avenues for **repair**. Repairing textiles can extend their lifetime and use for their owners.
- **Lending libraries** are a collection of items (e.g. tools) available for a community to borrow and use for little to no cost. Like a library of books, a lending library enables people to "check out" items for a given period of time, so individuals can access what they need without the barrier of needing to purchase and maintain items. A lending library might also have an educational component, where librarians can teach community members how to use and care for different items.

RECYCLING, UPCYCLING, AND DOWNCYCLING

Textile waste can be recycled through a couple of processes:

- Textiles made of natural fibers or polyester can undergo **mechanical recycling** to create new fibers used for new textiles. This process involves shredding fabrics to extract fibers. The extracted fibers are combined with virgin fibers and spun into yarn that can be used for woven or knitted fabric.
- Textiles made of synthetic fibers can undergo **chemical recycling** to create new synthetic fibers. The process of chemical recycling depends on the composition of textiles being recycled. Cotton textiles are often recycled through a depolymerization process that converts cotton fibers into a pulp, which is then converted into reusable fibers. For textiles made with a blend of natural and synthetic fibers, the only difference is that recycling processes use heat and/or solvents to melt and separate fibers to treat and spin them separately.
- Textiles that are that are too damaged to be recycled in either of the above methods and have a high water-absorption capacity can be cut down into **cleaning and wiping rags or used in local pet shelters.**

Due to the scale necessary for textile recycling and the small quantity of textile waste (around 12,000 tons/year), it is not recommended that the USVI build a textile recycling operation on-island. However, local textile upcycling programs are an opportunity that the USVI could pursue. Local textile upcycling programs, where textile wastes are used to make products such as art, reusable bags or blankets or rugs, could come in the form of DIY events for the community, micro-enterprises, and educational workshops. Paired with donation, consignment, and repair efforts, local textile upcycling operations have the opportunity to effectively reduce waste and create a culture of reuse in the USVI.

TIRES

While tires make up only 0.1 percent of the USVI waste stream, they represent a particular waste management problem because they cannot be landfilled.[253] A stock of used tires currently exists in storage piles within the territory, requiring additional management beyond the generation of new discarded tires. The following sections detail the identified materials management approaches for managing used tires, as guided by the EPA waste hierarchy.

SOURCE REDUCTION AND REUSE

While tires remain a necessary component of car and truck technologies, **adjusting driving and vehicle maintenance habits** can extend the usable lifespan of tires currently in use, reducing the flow of new used tires. Actions by vehicle owners, such as regular rotation and alignment, maintaining correct tire pressure, and driving more slowly around curves can all reduce tire wear. Programs encouraging these behavior shifts as well as efforts to advocate for road maintenance to reduce wear on tires could be effective at reducing territory-wide tire use.

RECYCLING AND COMPOSTING

Recycling tires into further usable products is possible through additional processing, such as baling. Baling tires into solid forms of various sizes significantly reduces total tire volume, improves sturdiness, and eliminates the public health risks associated with unbaled tires collecting standing water. Tire bales provide helpful applications in construction, such as the building of low-level retaining walls.[254]

MATERIALS MANAGEMENT APPROACHES SUMMARY

Many source reduction, reuse, recycling, and composting options exist for all the waste streams generated in the USVI. In addition, treatment through constructed wetlands can be pursued for wastewater in the territory. Exhibit A-4 below summarizes the materials management approaches with potential to manage waste streams in the USVI.

EXHIBIT A-4. MATERIALS MANAGEMENT APPROACHES BY WASTE STREAM

WASTE STREAM	SOURCE REDUCTION AND REUSE	RECYCLING AND COMPOSTING	ENERGY RECOVERY	TREATMENT
Bulk Waste (Including Furniture and Small Appliances)	✓	✓		
C&D	✓	✓		
Electronics	✓	✓		

[253] This is due in part to tires' large share of void space, potentially trapping methane gases and creating buoyancy issues beneath the surface of the landfill.

[254] Shredding tires also reduces total tire volume and creates a material potentially useful for construction as fill material. Tire shreds are not as stable as tire bales and potentially pose health risks due to harmful byproducts released during production, and are therefore not recommended for the USVI.

WASTE STREAM	SOURCE REDUCTION AND REUSE	RECYCLING AND COMPOSTING	ENERGY RECOVERY	TREATMENT
Glass	✓	✓		
Metals	✓	✓		
Organics (Including Excess Food, Yard Waste)	✓	✓		
Biosolids				✓
Paper	✓	✓		
Plastics	✓	✓		
Textiles	✓	✓		
Tires	✓	✓		