Prepared for:

CAPE COD COMMISSION
3225 Main Street
Barnstable, Massachusetts 02630

Final Task 2 and 3 Report: Options for Disposal, Processing, Tipping, and Transportation Municipal Solid Waste Out-Of-State Disposal Cost/Benefit Analysis

Prepared by:

Geosyntec Consultants
289 Great Road, Suite 202
Acton, Massachusetts 01720

Geosyntec Project Number: ME1979

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ABBREVIATIONS AND ACRONYMS

Formal names for offices, agencies, institutions, companies, products, and programs are capitalized; technical terms are in lower case.

AD	anaerobic digestion; anaerobic digestor
C&D	construction and demolition
CASP	covered aerated static pile
CCC	Cape Cod Commission
CCEP	Cape Cod Energy Park
CY	cubic yards
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
HH	household
ICI	industrial, commercial, and institutional
ISWM	Integrated Solid Waste Management (Facility operated by the Town of Bourne)
JBCC	Joint Base Cape Cod
LFG	landfill gas
LFGTE	landfill gas to energy
MassDEP	Massachusetts Department of Environmental Protection
mpg	miles per gallon
MRF	materials recovery facility
MSW	municipal solid waste
MTCO2e	metric tonnes of carbon dioxide equivalents
PAYT	pay as you throw
PPP	public-private partnership
RFP	request for proposal
SEMASS	Southeast Massachusetts Waste-to-Energy Facility (Covanta)
SF	square feet
SSO	source-separated organics
TPD	tons per day
TPY	tons per year
UCRTS	Upper Cape Regional Transfer Station
WARM	Waste Reduction Model (U.S. EPA)
WTE	waste to energy
YTS	Yarmouth Transfer Station

1. INTRODUCTION

1.1 Purpose and Terms of Reference

This Task 2 and 3 Report (Report) was prepared by Geosyntec Consultants, Inc. (Geosyntec) for Barnstable County consistent with the scope of work submitted to the Cape Cod Commission (CCC) and Barnstable County, as approved under Contract No. 500-21-7914A on 12 November 2020 for the project titled “MSW Out-of-State Disposal Cost/Benefit Analysis” (hereafter “Project”). The scope of work for the Project was outlined in the Request for Proposal (RFP) No. 7914 issued by the County on 20 August 2020, as described in Geosyntec’s proposal dated 1 October 2020 and further clarified in our letter to CCC dated 20 October 2020. Geosyntec has prepared this Report to present findings from Task 2 (i.e., Disposal Options) and Task 3 (i.e., Processing, Tipping, and Transportation Options) of the Project, with the primary goal of identifying long-term options for management of municipal solid waste (MSW) generated in towns in the Cape Cod and Islands Region of Southeast Massachusetts (hereafter “Cape and Islands”). For the purposes of this evaluation, Cape and Island towns include:

1. 15 towns in Barnstable County (Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, and Yarmouth),
2. Six towns on Martha’s Vineyard in Dukes County (Aquinnah, Chilmark, Edgartown, Oak Bluffs, Tisbury, and West Tisbury), and
3. Nantucket in Nantucket County.

The Massachusetts Department of Environmental Protection (MassDEP) has determined that in-state MSW disposal capacity will be increasingly limited in the near-medium term. This Project is thus intended to support Cape and Island towns by:

1. Securing medium to long term access to reliable out-of-state MSW disposal infrastructure,
2. Reviewing viable options for reducing the quantity of MSW for disposal through development of on-Cape processing capacity,
3. Providing the necessary transfer systems to support on-Cape processing and out-of-state MSW disposal, and
4. Reducing overall MSW management costs to towns and residents while minimizing environmental impacts.

Data and information used in Tasks 2 and 3 were assembled in collaboration with CCC and Barnstable County following a Request for Information issued by Geosyntec on 7 December 2020, supplemented where necessary with additional publicly available sources of information as well as conversations with private companies. It is noted that these tasks only concern disposed MSW (i.e., materials that currently end up in a landfill or incinerator) and do not include materials that are currently diverted for recycling, reuse, or other non-disposal disposition.

1.2 Project Background and Objectives

1.2.1 Background

Cape and Island towns are at risk of rising MSW disposal costs, primarily due to diminishing waste disposal capacity across New England as MSW landfills close and aging waste-to-energy (WTE) incinerators are operating at capacity. Additionally, the state has a moratorium on permitting new WTE facilities and the likelihood of permitting a new landfill is considered extremely low due to local opposition and other factors. At the same time, the draft MassDEP 2030 Solid Waste Master Plan outlines ambitious goals for waste reduction and diversion. However, recycling commodity prices, which were already depressed due to steep declines in exports to Chinese and other Asian markets following imposition of stringent rules on contamination levels since 2018, are under increasing pressure due to budgetary constraints affecting collection and operation of recycling systems. These factors drive recycling operators to recover their increased costs through renegotiation of materials recovery facility (MRF) processing agreements with local governments.

The lack of disposal capacity and available markets to process recyclable materials along with increasing transportation costs are negatively impacting MSW disposal budgets for municipalities across Massachusetts, including on the Cape and Islands. To address these issues and provide towns with information that can be used to plan for future MSW management, Barnstable County is working through the CCC and the Cape Cod Cooperative Extension on a companion project to this Project to assess waste reduction and diversion measures to reduce the volume of waste that requires disposal. Nonetheless, significant disposal needs remain, for which options for out-of-state waste transportation and disposal likely offer the most realistic and cost-effective solution, at least in the short to medium term.

In this Project, transportation of solid waste by truck and rail haul are examined along with long-term viability of disposal options, operational reliability, financial stability, and potential impacts from emerging technologies. This effort seeks to leverage potential opportunities with existing infrastructure, including the Town of Bourne Integrated Solid Waste Management Facility (Bourne ISWM) for landfill and processing options, the Cape Cod Energy Park (CCEP) in Yarmouth for railhead access and future waste technology capacity, the Upper Cape Regional Transfer

Station (UCRTS) for railhead access and processing options, and Joint Base Cape Cod (JBCC) for available land. The two railhead facilities and land are important infrastructure that could help address the MSW disposal challenges that Cape and Island towns are facing.

1.2.2 Project Objectives

The primary objective of this Project is to support the Cape and Island towns that are participating in this effort with their MSW management obligations, with a focus on reducing overall costs to towns and residents. The analysis will include four main components:

1. Identify likely options for rail transfer of wastes to out-of-state landfill facilities.
2. Identify short-term and long-term methods and costs for transporting MSW to out-of-state disposal facilities via rail in support of an economic analysis of transportation options.
3. Analyze short-term and long-term on-Cape processing and tipping options, including processing and tipping options for MSW that will eventually be disposed of at an out-of-state disposal facility. Options identified in the RFP include processing and tipping at individual town transfer stations and potential regional processing and tipping options at Bourne ISWM, the UCRTS, and the Yarmouth Transfer Station (YTS).
4. Analyze how food waste diversion could potentially reduce disposal and transportation costs for Cape communities (i.e., cost avoidance).

1.3 Assumptions and Limitations

In Task 1 of the Project (i.e., Quantify and Characterize Cape Cod MSW), Geosyntec reviewed the existing solid waste management and recycling system in Barnstable, Dukes, and Nantucket Counties and prepared a technical memorandum (memo) to describe findings from a desk study evaluation of the quantity and characteristics of MSW generated on the Cape and Islands as well as the current cost for MSW disposal incurred, the current MSW hauler, and the current disposal facility serving each town. Based on this, projections of future waste disposal needs were developed. Geosyntec also reviewed the potential tonnage of food scraps and other organics that could be recovered from MSW for on-Cape processing. Geosyntec's final revised Task 1 memo was submitted to CCC on 26 May 2021. Findings from Task 1 serve as the baseline for defining future MSW disposal system requirements in Tasks 2 and 3. Overall, the primary findings from Task 1 were as follows:

1. Cape and Island towns served 112,602 households in 2020 (about 2,500 more than in 2019) and handled a total of 84,465 tons of MSW for disposal (about 1,600 tons more than in 2019). Data for 2020 represented service to approximately 68% of the reported

164,899 households on the Cape and Islands. Overall, a conservative value of 85,000 tons per year (TPY) is assumed to represent the current MSW quantity handled by Cape and Island towns.

2. Population dynamics and historical waste generation reported over the last ten years suggest that population trends will be flat or slightly declining with future waste generation lower than current rates. However, given the significant seasonal variation in populations of many towns and the need for this Project to provide conservative estimates of future waste management challenges, a zero rather than declining growth rate is assumed for all waste streams.
3. Only four towns offer curbside collection services. Residents not served by curbside collection must bring MSW to their town's drop-off center or contract with a private commercial hauler. MSW collected curbside or at drop-off centers is either direct hauled to a disposal facility or is consolidated at a small town-owned transfer facility or the CCEP prior to hauling. The UCRTS is not currently used for MSW transfer but serves as a privately operated construction and demolition (C&D) waste facility.
4. The Bourne ISWM Facility currently serves the MSW disposal needs of Bourne and Falmouth. Most towns predominantly send their MSW off-Cape to either Covanta's Southeast Massachusetts (SEMASS) WTE Facility in Rochester, Plymouth County or the Crapo Hill Landfill in New Bedford, Bristol County. The Middleboro Landfill and other off-Cape landfills are also used depending on hauler routing and schedules.
5. Based on regional waste composition data, about 30,000 TPY of food waste and other organics may be recoverable from the MSW disposal stream. An additional 3,000 TPY of cardboard may also be recoverable along with some C&D waste components and textiles. In the interests of conservatism, however, only the potential for increased food waste and organics diversion is further explored as a mechanism to reduce the total quantity of MSW requiring out-of-state transfer and disposal.

It is noted that the only two operating landfills on the Cape and Islands are the Bourne ISWM Facility and the small landfill on Nantucket. The Bourne ISWM serves Bourne and Falmouth under a long-term contract and accepts WTE incinerator ash from SEMASS under contract. Currently, WTE incineration ash represents the majority (about 85%) of the facility's annual disposal. Although Bourne is working towards a major expansion to provide capacity well into the 2030s, it is Geosyntec's understanding that the ISWM Facility does not represent a viable on-Cape disposal option to serve the long-term needs of all Cape and Island towns. Nantucket also plans to continue use of its on-island landfill, but only for disposal of post-processing residues from its co-composting facility. Overall, however, the volumes of MSW that are sent to on-Cape landfills are quite small and do not significantly impact the assumption that the total tonnage for assessment in Task 2 and 3 is 85,000 TPY.

MassDEP has predicted that in-state MSW disposal capacity at WTE facilities and landfills will be increasingly limited in the near-medium term; therefore, out-of-state disposal options will be needed as identified in the RFP. Initially, Geosyntec considered options for trucking MSW to regional WTE facilities or landfill. In our experience, the maximum practical one-way distance for truck-based hauling of MSW is approximately 150 miles; therefore, this distance was used to screen for potentially available disposal options. Options for truck-based hauling to landfills in New York, New Jersey, Pennsylvania, or Canada were thus not explored further as these would be cost prohibitive. Based on a review of operating landfills within 150 miles of Cape Cod, none are available that are willing to both accept out-of-state waste and have more than 10 years of remaining permitted disposal capacity. Therefore, further analysis of landfill options in New England has also not been considered. A similar situation exists with regional WTE capacity. The February 2019 Massachusetts Materials Management Capacity Study indicated that WTE facilities in Connecticut and Maine are running at capacity and accept only small amounts of MSW from Massachusetts. Due to the lack of available WTE capacity, no further analysis of WTE options in New England has been considered for this Project. Based on these findings, this Project assumes that long-haul rail transportation to out-of-state landfills will be the only method used for transfer of MSW for disposal.

Changes in technology and/or waste disposal regulations, as well as mandates for diversion and recycling over the expected lifecycle of an out-of-state disposal contract may have significant impacts to MSW disposed in the long-term. However, with the exception of composting and anaerobic digestion (AD) of segregated food waste and other organics, it is Geosyntec's opinion that other emerging technologies for processing of certain components of MSW such as pyrolysis, gasification, or cellulosic fermentation are not sufficiently well established on a commercial scale to be considered further in this Project. Similarly, the poor performance of U.S.-based projects that have attempted to process materials recovered from mixed waste processing facilities (often referred to as advanced materials recovery facilities or "dirty MRFs") rules out consideration of commercially available mixed waste processing options. Therefore, the only non-landfill option considered will be small-scale on-Cape composting or AD of source-separated food waste and other organics.

For economies of scale to function effectively to secure a long-term disposal contract that reduces overall MSW management costs to towns and residents, it is assumed that all 22 towns listed in Section 1.1 will participate jointly in an option for out-of-state rail transfer via a contract mechanism administered by the County, or another special purpose entity. As noted above, it is recognized that a relatively small quantity of waste may continue to be sent to on-Cape landfills.

In addition, an increasing quantity of food waste and other organics may be separated for on-Cape processing using composting or AD systems, further reducing the total assumed quantity of MSW that requires out-of-state disposal. However, in the interests of conservatism it is assumed that the quantity of MSW for out-of-state disposal will remain consistent at 85,000 TPY. This allows for potential temporary or permanent disruptions to on-Cape processing or disposal.

2. DISPOSAL OPTIONS

2.1 Overview and Criteria for Assessment

In fulfilment of the scope for Task 2, Geosyntec researched out-of-state MSW disposal options and completed an analysis of each option in accordance with criteria established here.

Please note that this review is not intended as an exhaustive review of potential options should the County proceed with establishing a rail transport and disposal contract; rather, it is meant to identify likely market participants and locations. Where data were incomplete or nonconclusive, Geosyntec used our best professional judgment.

2.1.1 Quantities of Waste for Disposal

From Task 1, the total assumed annual amount of MSW to be managed is 85,000 TPY. Note that this includes Bourne and Nantucket tonnage as well as food waste and other organics. In the future, even though food waste may not routinely be transferred for disposal, there is still the possibility for plant upsets as well as residues and rejects that will routinely require disposal; therefore, in order to be reasonable and conservative for this analysis, Geosyntec's analysis assumes 85,000 TPY must be managed consistently. This equates to an average of about 300 tons per day (TPD) assuming a 300-day working year. However, it is important to note that while most communities in the U.S. experience seasonable fluctuations in waste generation, the seasonality for Cape and Islands towns is extreme. It is estimated that approximately one third of the waste generated on the Cape and Islands occurs during July and August. Therefore, transfer infrastructure and the receiving landfill must be able to handle twice the average daily waste flow, or up to 600 TPD, to accommodate higher waste volumes during peak months.

2.1.2 Primary Criteria for Assessment

As part of reviewing potential out-of-state disposal facilities that could realistically accept MSW from Cape and Island towns for a multi-year contract and building on the overall assumptions listed in Section 1.3, the following minimum criteria were applied:

1. The landfill must have permitted disposal capacity in excess of 10 years. While it is recognized that landfills often pursue additional disposal capacity, it was beyond the scope of this Project to assess the probability that applications to expand capacity would be permitted in a timely manner.
2. The landfill must have existing infrastructure to accept waste by rail.
3. The sole Class 1 railroad that serves Cape Cod is CSX; therefore, it is assumed that CSX will be the interstate rail service provider. Accordingly, the landfill either must have direct

access to CSX's rail network or have an existing short line railroad or other suitable "last mile" transfer service. Geosyntec only included facilities that have previously or are currently receiving waste by rail such that their ability to complete the last mile through non-CSX transportation has been established.

4. The landfill facility provides a single contract which includes disposal, rail transportation and logistics as well as rail car leases.

Inability to meet these minimum criteria was considered a fatal flaw in the analysis and resulted in a candidate landfill being dropped from further consideration.

2.1.3 Secondary Criteria

In addition to the minimum criteria listed above, several secondary criteria were applied during the process of reviewing candidate landfills. These represent important considerations that need to be worked out to the County's satisfaction prior to establishing a contract. Although a facility's inability to meet one or more of these criteria may ultimately represent a fatal flaw, these criteria were not investigated in sufficient detail to develop meaningful conclusions for any candidate site at this stage of the Project.

1. Assuming total MSW volumes of 85,000 TPY, the facility must have sufficient capacity to handle 85,000 TPY, representing 800 railcar containers per year in addition to their ongoing operations. The facility should also have sufficient railcar storage to accommodate expected peak flows of 600 TPD during July and August; therefore, facilities that already handle large volumes of waste from communities with significantly higher summer waste flows should be carefully scrutinized.
2. The facility should not have any ongoing operational, environmental compliance, or sociopolitical issues that could result in the County and the participating Cape and Island towns being indirectly associated with litigation or suffering negative publicity.
3. Preferably, the facility location should offer opportunities for backhaul (i.e., use the same rail cars for transport of materials back to Cape Cod) to minimize the expense and wastage of running empty railcars on the return trip.

It is expected that the large regional landfills reviewed as part of this task will meet these criteria.

2.2 <u>Options for Consideration</u>

Based on the criteria listed above, Geosyntec was able to identify six candidate landfills that have CSX rail access and a track record of providing waste by rail services. As shown on Figure 2-1 overleaf, these sites are operated by four different companies and are located in Virginia, Ohio, South Carolina, and Georgia. A brief description of each facility grouped by operator is provided below, listed in order of increasing haul distance from Barnstable County.

No.	Landfill	State	Operator	Distance (miles)
1	King George	Virginia	Waste Management	560
2	Atlantic Waste Disposal	Virginia	Waste Management	660
3	Sunny Farms	Ohio	Waste Innovations	800
4	Tunnel Hill Reclamation	Ohio	Waste Innovations	800
5	Lee County	South Carolina	Republic Services	920
6	Taylor County	Georgia	GFL Environmental	1,200

Note. Distances shown are approximated and have not been verified as actual CSX rail haul distances.

Figure 2-1: Active Waste-by-Rail Landfills Served by CSX

2.2.1 Waste Management, Inc.

Waste Management, Inc. operates two candidate landfills in Virginia that are served by CSX:

1. King George County Landfill[1] located at 10376 Bullock Drive, King George, VA 22485, and
2. Atlantic Waste Disposal[2] located at 3474 Atlantic Lane, Waverly, VA 23890.

Both facilities have an estimated remaining disposal capacity of over 20 years. King George has direct access to via CSX rail and currently accepts waste via gondola cars. Atlantic Waste requires a short transfer from CSX into the on-site rail unloading facility and accepts waste in intermodal containers. Located about 560 or 660 miles from the interconnection to the Cape Cod line in Barnstable County, respectively, both King George and Atlantic Waste would have an estimated turnaround time on railcars of approximately 15 to 20 days.

2.2.2 WIN Waste Innovations

WIN Waste Innovations (formerly Tunnel Hill Partners) operates two rail served landfills in Ohio:

1. Sunny Farms Landfill[3] located at 12500 W. County Road 18, Fostoria, OH 44830, and
2. Tunnel Hill Reclamation Landfill[4] located at 8822 Tunnel Hill Road, New Lexington, OH 43764.

Both landfills are served directly by CSX, although Tunnel Hill Reclamation requires a short-line transfer of about 30 miles. Waste is received by both gondola and intermodal rail containers. These two landfills each have over 15 years of remaining capacity. Located about 800 miles from the interconnection to the Cape Cod Line in Barnstable County, both landfills would have an expected turnaround time on railcars of between 15 and 20 days.

It is noted that Tunnel Hill Reclamation currently receives C&D waste by rail from UCRTS, which is privately operated by Cavossa Disposal. C&D debris is transported from UCRTS to the landfill in gondola cars.

2.2.3 Republic Services, Inc.

Republic Services, Inc. operates the Lee County Landfill[5] located at 1431 Sumter Highway (Highway 15) in Bishopville, SC 29010. The facility is directly served by CSX rail and is currently receiving waste in intermodal containers from across the Northeast. Following a recent

[1] https://www.wmsolutions.com/locations/details/id/237

[2] https://www.wmsolutions.com/locations/details/id/235

[3] https://tunnelhillpartners.com/affiliate-services/landfills/sunny-farms-landfill/

[4] https://tunnelhillpartners.com/affiliate-services/landfills/tunnel-hill-reclamation-landfill-thr/

[5] https://wastebits.com/locator/location/lee-county-landfill-1

expansion, the landfill has an estimated remaining capacity of 75 years. Located over 900 miles from the interconnection to the Cape Cod Line in Barnstable County, it is expected that the turnaround time on railcars would be approximately 18 to 28 days.

2.3.4 GFL Environmental

GFL Environmental operates the Taylor County Landfill[6] located at 33 Stewart Road, Mauk, GA 31058. GFL has historically been a large waste services provider in Canada, but with recent acquisitions of U.S. facilities has also become a large service provider in the Southeast and Midwest. Taylor County is served directly by CSX and is permitted for continuous operation with no volume restrictions. The facility is reported to have 50 years of remaining capacity. At over 1,200 miles from the interconnection to the Cape Cod Line in Barnstable County, it is estimated that between 20 and 30 days would be required for a unit train to make the round trip from Cape Cod.

[6] https://gflenv.com/taylor-county-landfill/

3. PROCESSING OPTIONS

3.1 Overview and Criteria for Assessment

As part of Task 3, Geosyntec investigated potential options for on-Cape processing of food waste and other organics to reduce the long-term demand for MSW disposal.

3.1.1 Quantities of Organics in Disposal Waste Stream

Based on regional waste composition studies examined in Task 1, significant quantities of compostable organics may be recoverable from the MSW disposal stream handled by Cape and Island towns, primarily from the residential sector. The data suggest that much of the disposal waste stream may be recoverable organics, comprising food waste (18%), compostable paper (9%), and yard waste and other organics (9%). Based on a total compostable fraction of 36% and total MSW tonnages reported in 2019, the total compostable quantity of MSW (hereafter "organics") delivered into the towns' solid waste management systems by participating households in each county is listed in Table 3-1 below in TPY and TPD, with the latter value calculated assuming a 300-day working year.

Table 3-1: Quantities of Organics in Disposal Waste Stream

County	Participating Households	Total Organics (TPY)	Total Organics (TPD)	Total Organics (lbs./HH/year)
Barnstable	92,483	23,760	79	1.4
Dukes	8,698	1,960	7	1.2
Nantucket	8,871	4,100	14	2.5

Notes. Data for 2019. Dukes County includes Martha's Vineyard only.

It is noted that residential waste is not subject to MassDEP regulations[7] requiring large generators of food waste to implement recovery programs. As such, programs to increase residential organics recovery on a town-by-town or community basis on the Cape and Islands as discussed below can be planned without regard to the timetable for compliance by large generators. Notwithstanding, Geosyntec estimates that over 100 food waste generators on the Cape and Islands with total tonnage of over 12,600 tons per year may be subject to the existing one-ton per week threshold, rising to nearly 230 generators and over 16,800 tons/year under the upcoming half-ton per week threshold. Large food waste generators are concentrated in Barnstable County. Overall, it is expected that significant interest should exist among the industrial, commercial, and institutional (ICI) sector in implementing food waste processing systems. Although beyond the scope of this Project, Cape and Island towns could work with these

[7] https://www.mass.gov/doc/310-cmr-19000-commercial-organic-material-waste-ban-amendments/download

generators to develop and operate composting or AD systems with sufficient capacity to meet the needs of both the ICI and residential sectors.

3.1.2 Assumptions and Criteria for Assessment

Based on the logistical difficulties of delivering organics from the islands for processing in Barnstable County, it is assumed that organics generated on Martha's Vineyard and Nantucket will remain on those islands for processing (Nantucket already operates a co-composting facility). This Project thus focuses on developing organics processing capacity in Barnstable County. A similar system on a much smaller scale to that presented here may be implemented independently by towns or communities on Martha's Vineyard. Alternatively, communities could focus on backyard composting as recommended below.

In accordance with the assumptions previously outlined in Section 1.3, beyond backyard or community-scale composting, the only options considered are small-scale composting or AD facilities that process source-separated organics (SSO), that is organics that are removed from the mixed waste stream by households and either collected curbside or delivered separately to drop-off centers. Options that attempt to utilize advanced processing technologies to separate organics from a mixed waste stream are not considered due to their high costs, operational complexity, and unproven efficacy.

For any SSO processing option beyond backyard or community-scale composting, providing robust mechanisms for separation of organics typically represents the most challenging aspect of developing cost-effective operations. The simplest approach, at least in the initial stages of proving SSO processing, would be to expand the towns' existing drop-off centers to provide separate areas for source-separated food and yard waste. This approach is recommended until the longer-term viability of SSO processing can be verified. For towns that currently offer curbside trash collection, these programs could be extended to include separate collection of SSO, either by using "split-back" collection vehicles with separate compartments for SSO and trash, or by providing collection services on different days. Such programs could also be expanded to collect SSO from county/municipal government buildings and public schools. Expanding curbside collection to include separate collection of SSO will invariably drive up collection costs charged to participating households. Due to the number of alternative approaches available and the expectation that each town will adopt separate methods, the specifics of SSO collection are not considered further in analysis of SSO processing options in this section.

Some options to consider for increasing participation rates include implementing pay-as-you-throw (PAYT) programs to either provide a financial incentive for greater recycling and participation in SSO collection or a penalty for not doing so. As was discussed in the Task 1 memo, several Cape and Island towns have already implemented PAYT; as such, the level of public pushback to expanding PAYT may be minimal. However, PAYT programs have been shown to increase contamination in the recycling and organics waste stream as residents are discouraged from using their trash bins. As such, towns should expect to implement an enforcement and citation program in coordination with PAYT to reduce contamination in SSO collection bins, which may prove expensive.

3.2 Options for Consideration

3.2.1 Encourage Backyard and Community-Scale Composting

Backyard and community composting should be encouraged by CCC and the towns to help meet organics diversion goals. Organics that are composted at home or in the local community do not enter the disposal waste stream, automatically lowering the towns' overall costs for MSW management. Backyard composting may be encouraged by providing residents with subsidized or complimentary backyard composting units while also implementing education and outreach programs to encourage the practice. Local codes may need to be updated to allow for such practice. Based on Geosyntec's experience, extensive outreach efforts would be required on the part of CCC and the towns to encourage widespread use of backyard composters. If backyard composting is encouraged as part of an organics diversion program, it is important to note that success can be difficult to measure as it relies on self-reporting on the part of residents. However, CCC or the towns could set up an online portal/phone number where residents could self-report, which could be advertised by distributing educational materials.

Participation in backyard and community composting programs can be cost-effectively encouraged through PAYT and other tiered pricing models that effectively reward households for avoiding generation of organic waste (or penalize households that do not participate by imposing higher fees for collection) and/or by providing grants or subsidies to local community composting initiatives. CCC and the towns could also help launch urban/suburban farming, community gardens, and/or "adopt a lot" programs to turn empty lots into parks and gardens. Encouraging these types of programs would increase both the production and the local demand for compost by increasing residents' access to composting while also increasing the need for compost in newly created green spaces. In addition to community gardens, creation of school gardens at public schools could be considered. These gardens can act as hands-on facilities where children learn about sustainable gardening, waste reduction, and composting.

3.2.2 Develop Decentralized Organics Processing Capacity

Towns may develop SSO processing capacity by:

1. Building, permitting, and operating facilities directly, either on their own, in cooperation with neighboring towns, or under a special purpose public entity,
2. Partnering with private companies to design, build, and operate facilities under a public-private partnership (PPP), or
3. Contracting with private companies to accept organics for processing at private facilities.

Additional discussion of contracting options and associated risks and benefits will be provided in Task 4 of this Project.

Rather than constructing a single, large SSO processing facility to serve all of Barnstable County, a decentralized approach is recommended in which multiple, small facilities are developed. Based on a decentralized approach, Geosyntec looked at developing three small-scale facilities across Barnstable County by grouping the 15 towns into three sub-regions (i.e., Outer/Lower Cape, Mid-Cape, and Upper Cape) as shown in Figure 3-1 below.

Figure 3-1: Sub-regions within Barnstable County

The main advantage of a decentralized approach is redundancy. If there is a problem with one facility, SSO feedstock could be relatively easily transferred to the other facilities. Decentralized systems are thus more robust to climate change impacts such as flooding or storms. Another advantage of decentralization is that it allows processing capacity to better match demand and requires less upfront capital risk. Total processing capacity can be scaled up over time to match demand (i.e., one facility can be developed as a "proof-of-concept" pilot before additional facilities are developed).

A breakdown of participating households in each sub-region indicates approximately equal SSO generation of 25-30 TPD per sub-region as summarized in Table 3-2 below.

Table 3-2: Quantities of Organics from Sub-Regions in Barnstable County

Sub-Region	Participating Households	Total Organics (TPY)	Total Organics (TPD)	Total Organics (Percent of Total)
Outer/Lower Cape	28,799	7,800	26	32.8%
Mid-Cape	25,065	7,510	25	31.6%
Upper Cape	38,619	8,450	28	35.6%

Notes. Data for 2019. Percent of total is for Barnstable County only.

Final locations for SSO processing facilities in each sub-region can be established later following discussion between the towns in each sub-region and identification of suitable sites. In general, SSO processing facilities would benefit from being co-located with existing drop-off or transfer facilities or developed as part of a resource recovery park. Candidate sites include:

1. Outer/Lower Cape: Brewster Recycling Center
2. Mid-Cape: CCEP or Dennis Town Disposal Area
3. Upper Cape: Bourne ISWM Facility, UCRTS, or vacant land on JBCC

Please note that Geosyntec has not assessed the suitability of any site listed above, which are preliminary suggestions based mainly on their centralized location and ability to leverage existing waste management infrastructure.

Options for decentralized organics processing facilities include composting or AD facilities. For analysis, it is assumed that these would be composting facilities operated as covered aerated static piles (CASPs), the dominant technology used for organics processing in the U.S. However, other composting or AD technologies may be employed if at comparable performance and costs. As such, use of the term "composting facility" in this discussion is for simplicity only and does not imply an endorsement of CASPs over any other technology.

Development and operation of the composting facilities were estimated based on the following assumptions:

1. The nominal capacity of each composting facility developed would be 10,000 TPY, conservatively larger than the 7,500 to 8,500 TPY capacity required based on the calculations in Table 3-2. This oversizing allows for some seasonal variation in throughput and provides for intra-facility redundancy. Oversizing also allows for the addition of bulking agents (most likely trees and other plant material from town parks and recreation facilities and/or yard waste from commercial landscapers) to improve the processing time and quality of compost product generated. This facility size also reflects the historical "sweet spot" for successful operations reported by U.S. food waste composting facilities, although larger facilities are now being developed as experience with food waste composting grows.
2. Each facility would comprise five CASP units each with a capacity of 2,000 TPY. Each CASP unit requires concrete pads, covers, aerators, temperature probes, leachate management, and miscellaneous other fixed equipment for operation (see Figure 3-2 overleaf).
3. Facilities would operate eight hours a day, five days a week, 52 weeks a year.
4. Facilities would require an operational footprint area of only two-three acres. However, larger lots would provide more flexibility and scope for expansion if needed.
5. It is assumed that each facility would require at least one front end loader for moving organics and finished compost product, as well as a grinder to break down large items (e.g., stumps). Staffing requirements include one full-time supervisor and four full-time equivalent workers.
6. Contamination is expected to represent about 20-25% of the incoming mass of organics (i.e., this material would need to be screened out and landfilled) with about 30-35% of the original mass becoming saleable compost product. The remaining mass is off gassed to carbon dioxide and other gases.
7. Sale of compost product can help offset operating costs. High-quality compost generated from combined food and yard waste can sell for roughly $30 per cubic yard (CY).

Figure 3-2: Large CASP Facility in Operation in Prince George's County, Maryland

4. TIPPING AND TRANSPORTATION OPTIONS

4.1 Overview and Assessment of Existing Assets

There are currently two rail-capable transfer stations on Cape Cod: YTS and UCRTS. As part of the scope for Task 3, a brief description of the rail transfer capacity required to manage an annual amount of 85,000 tons of MSW is described in this section along with as assessment of these existing transfer stations' capabilities for managing tipping and loading of MSW into rail cars for long-haul transportation.

4.1.1 Rail Transfer Requirements

If MSW was generated at a steady state throughout the year, 85,000 TPY would represent approximately 300 TPD assuming a six-day working week. However, due to the high seasonality of waste generation on the Cape and Islands, waste generation is estimated to peak at approximately 600 TPD during July and August. Therefore, the transfer facilities must be able to manage the number of railcars required for this peak throughput.

Typical railcars can transport between 100 and 110 tons of MSW. Therefore, 85,000 TPY represents approximately 800 railcar loads that must be transported each year. During the peak season, it is expected that six railcars will have to be loaded each working day.

Due to the need to minimize the duration for which MSW is stored once a railcar is filled, waste is typically transported by unit trains; that is, a discrete number of cars that are shipped on a regular schedule without being split up or stored. Based on information provided by the waste companies surveyed in Section 2 of this Report, typical unit trains contain between 60 and 100 railcars. Assuming a 60-car unit train in the interests of conservatism, Table 4-1 overleaf provides a conceptual railcar inventory during the peak season assuming a 24-day turnaround period for transportation to the receiving landfill, unloading at the landfill, and return of empty cars to Cape Cod. In this scenario, two unit trains would need to operate, with one train arriving every 12 days to return a set of empty cars and leave with a set of loaded cars. To provide two days of excess capacity of railcars in case of a delay in the arrival of the unit train, it is estimated that the transfer station on Cape Cod would have to provide storage for a maximum of 66 railcars.

Based on this review, for a single transfer station to manage all MSW generated by participating households on the Cape and Islands, the facility must be able to load up to 600 TPD of MSW into railcars as well as have capacity to store up to 66 rail cars on site.

Table 4-1: Estimated Railcar Inventory During Peak Season

Calendar Day	Weekday	Railcars Loaded	Empty Railcars Arriving	Empty Railcars in Storage
1	Monday	6		66
2	Tuesday	6		60
3	Wednesday	6		54
4	Thursday	6		48
5	Friday	6		42
6	Saturday	6		36
7	Sunday	0		36
8	Monday	6		30
9	Tuesday	6		24
10	Wednesday	6		18
11	Thursday	6		12
12	Friday	6	60	66
13	Saturday	6		60
14	Sunday	0		60
15	Monday	6		54
16	Tuesday	6		48
17	Wednesday	6		42
18	Thursday	6		36
19	Friday	6		30
20	Saturday	6		24
21	Sunday	0		24
22	Monday	6		18
23	Tuesday	6		12
24	Wednesday	6	60	66

In addition to assessing the existing transfer stations' ability to provide full waste-by-rail service to the towns, Geosyntec considered truck transfer as a mechanism to handle peak waste flow or provide contingency service in the event of an emergency situation (e.g., rail outage). However, the transfer stations are not equipped for loading waste into truck transfer trailers and retrofitting them to do so would be challenging and expensive. As such, truck transfer as an alternative mechanism for managing peak volumes is not considered feasible. Furthermore, the off-route time for collection vehicles to transport additional volumes to SEMASS during high peak situation would be operationally inefficient. The associated loss of productivity and potential to not finish routes would also potentially have significant consequences on the towns' quality of service. Regarding emergency situations impacting rail service, the risk of this occurring is low as regularly scheduled unit train rail service, as proposed, is highly reliable. Indeed, road service is far more suspectable to disruption than rail service. Major rail transfer facilities in New York and Maryland, for example, have been operating with no trucking back-up options for more than 20 years. Furthermore, the analysis of rail cars described previously provides standby cars for the unlikely case where a train is significantly delayed.

4.1.2 Yarmouth Transfer Station

The existing YTS is currently operated under contract by Covanta as a waste by rail facility that ships MSW to SEMASS using gondola cars. Once filled, a lid is placed to cover the cars before shipment. The facility manages waste that is collected by private haulers from Brewster, Dennis, Yarmouth, and other sources on Cape Cod. Current throughput is approximately 500 TPD, with a permitted limit of 530 TPD. The facility has six unloading bays and a total tipping floor area of approximately 7,000 square feet (SF) with concrete push walls approximately 15 feet tall on either side of the loading bays. This arrangement allows for the loading of two rail cars simultaneously and provides temporary storage capacity on the tipping floor to manage surges in waste receipts of temporary delays in loading out railcars. A photo of YTS is provided in Figure 4-1 below.

Figure 4-1: Yarmouth Transfer Station

Based on site reconnaissance by Geosyntec and discussions with the facility operator, YTS appears to have the throughput capacity and sufficient storage for up to 70 railcars, although some maintenance to the tracks may be required. Therefore, our assessment is that YTS is likely able to physically manage the transfer the 85,000 TPY of MSW estimated as part of this Project, however, the peak rate of 600 TPD that is expected during summer months will require a revision to the operating permit.

It is our understanding that Covanta operates the facility under an initial 10-year contract with the Town of Yarmouth that includes three 5-year optional extensions. Should the County move forward with a waste-by-rail transfer contract using YTS, coordination will be required regarding timing of the operational transfer.

4.1.3 Upper Cape Regional Transfer Station

The existing UCRTS is located on JBCC and is currently operated under contract by Cavossa Disposal as a waste by rail facility that ships C&D debris to out-of-state landfills using gondola cars. Once filled, a lid is placed to cover the cars before shipment. The facility manages waste that is collected by private haulers on Cape Cod. Current throughput at the facility averages less than 100 TPD, although the permitted capacity of the facility is 89,100 TPY. The facility has three unloading bays and a total tipping floor area of approximately 6,000 SF with a reinforced push wall that is approximately 10 feet in height on one side of the building. The facility has a single loading bay for railcars. A photo of UCRTS is provided in Figure 4-2 below.

Figure 4-2: Upper Cape Regional Transfer Station

From site reconnaissance by Geosyntec and discussions with the facility operator, UCRTS appears to have rail storage for up to 70 railcars. Based on the size of the existing building and the single loading bay for rail cars, it is our opinion that the facility would be at the upper limit of its operating capacity at a peak throughput of 600 TPD. This means is that there would be little excess capacity when operating under peak conditions such that any operational disruptions (e.g., equipment breakdown or an unusual surge of trucks arriving at one time) would likely result in delays for incoming trucks waiting to unload. Therefore, our assessment is that while UCRTS has the permitted capacity to transfer all 85,000 TPY of MSW annually, a more detailed assessment should be made regarding the need for facility upgrades to reduce the risk of operational slowdowns.

Cavossa currently operates UCRTS under a contract that ends in December 2023 with a possible extension to December 2025. It is important to note that one of the provisions of the operating contract is that JBCC has the right to take over operation of the transfer station for its own use at any time. While this has not been an issue during Cavossa's time in operation, it is an uncertainty that would have to be addressed should the County elect to use the facility for managing MSW.

4.2 Options for Consideration

Based on the facilities available, the following options have been identified for out-of-state transfer of MSW by rail:

1. Option 1: Develop only YTS,
2. Option 2: Develop only UCRTS, or
3. Option 3: Develop both YTS and UCRTS

Another option that is theoretically available is to either convert one of the existing transfer stations to load tractor trailers, or develop a new transfer facility for tractor trailers and perform a short truck-based transfer of MSW to a rail-accessible transfer station located off Cape Cod. For example, there is an existing transfer station on rail that was identified in Taunton, Massachusetts (60 miles away from Cape Cod) that is owned by Wheelabrator Technologies. However, operation of a truck-based transfer station as an intermediate transfer to a rail-based transfer station would add significant costs to simply using one or both existing on-Cape rail transfer facilities. This is because there would be little or no economy of scale to adding waste from Cape and Island towns to an existing rail transfer station and therefore the cost of operating the truck transfer station on Cape Cod would be directly added to the cost of out-of-state rail transportation and disposal. For example, a rule-of-thumb cost for waste transfer trucking is $1,200 per day. A 60-mile one-way travel distance would yield no more than four round trips per day, and at 20 tons per trip, truck transportation alone would be approximately $15 per ton with additional costs for loading and operation of the truck transfer station. The addition of these costs on top of the cost for rail transport and landfill disposal make this theoretical option uneconomical; therefore, it was eliminated from further consideration.

The options of developing either the existing YTS or UCRTS as a standalone facility for out-of-state rail transfer were discussed previously in Section 4.1. It is noted that while no fatal flaws were identified, some work remains for either Option 1 or Option 2 to be confirmed as viable.

For Option 3, both existing on-Cape transfer stations would provide dual service. Under this option, it is assumed that waste from the mid-Cape, Lower Cape, and Outer Cape sub-regions (see previous Figure 3-1) would be delivered to the YTS under typical operating conditions, with only local waste from the Upper Cape sub-region going to the UCRTS. Based on a breakdown of tonnages between the different sub-regions, this would result in about 64% of MSW being routed through YTS with 36% being routed through UCRTS. The benefit of this option is that it provides redundancy in the event of a disruption in service at one transfer station, as the other facility can temporarily handle more waste. It also keeps waste receipts at YTS within currently permitted limits and offers a more realistic operational role for UCRTS, which could struggle to handle 600 TPD on a regular basis.

It is noted that for any of these options, it is assumed the County will need procure the services of a third-party company to provide rail transport and disposal. The specifics of this transport and disposal agreement along with estimated costs will be address in the Task 4 report.

5. ENVIRONMENTAL ASSESSMENT OF OPTIONS

5.1 Overview and Methodology

As a surrogate measure of overall environmental performance, the potential impacts or benefits of transitioning from the current decentralized system of local/regional disposal (i.e., baseline system) to a centralized out-of-state landfill disposal system were estimated using the U.S. EPA's Waste Reduction Model (WARM). This straightforward model serves to track greenhouse gas (GHG) emissions from AD, composting, WTE combustion, and landfilling. WARM thus provides a simple, uniform, and widely accepted method of estimating GHG emissions from the different processing and waste disposal options laid out previously in this Report. However, WARM can only analyze GHG emissions associated with road transportation and not the other methods identified in this Report (i.e. rail and barge); therefore, a supplemental analysis of GHG emissions related to transportation was also performed.

The lifecycle GHG emissions associated with providing an out-of-state MSW disposal solution through implementing a combination of options from Sections 2 through 4 will vary depending on the final disposal, tipping, and transportation options selected as well as whether Barnstable County and the participating Cape and Island towns elect to move forward with including development of on-Cape organics processing capacity.

5.1.1 Methods and Assumptions for Calculating GHG Emissions

For the existing system (baseline) and each proposed waste disposal option, GHG emissions from processing/disposal were analyzed using default emission factors included in WARM for landfilling, WTE combustion, composting, or AD. GHG emissions from transportation were calculated using published data for fuel efficiencies and emissions factors for various transportation methods.

Specific assumptions used to calculate GHG emissions for processing/disposal using WARM are listed below:

1. All Landfills used for the existing waste disposal systems were assumed to provide landfill gas (LFG) collection to reduce methane emissions. It was further assumed that captured methane is utilized in an on-site landfill gas-to-energy (LFGTE) facility at the Crapo Hill and Middleboro landfills to generate electricity and offset equivalent electricity production from fossil fuels. LFG collected at the Bourne ISWM facility was assumed to be flared.
2. All landfills proposed for waste-by-rail disposal were assumed to provide LFG collection to reduce methane emissions. It was further assumed that captured methane is utilized

in an on-site landfill gas-to-energy (LFGTE) facility to generate electricity and offset equivalent electricity production from fossil fuels.

3. The framework for WARM does not allow for paper products to be composted. However, as the GHG emissions factors for combustion of other organic materials (e.g., food waste and yard waste) are broadly similar to those for composting for those organic materials in WARM[8], composting of compostable paper was modeled as equivalent to combustion.
4. Travel distances were neglected in the WARM analysis as GHG emissions associated with transportation of waste were calculated separately.

Transportation related GHG emissions were calculated using the procedures and assumptions listed below:

1. Existing transportation routes and transfer methods (e.g. truck, barge, or rail) were identified for each town. These were used to assess GHG emissions under the existing system (baseline). For future options utilizing long-haul rail transfer, it was assumed that existing local collection and transfer methods would remain in effect except that all waste would be redirected to YTS and/or UCRTS from where it would be loaded onto railcars for out-of-state disposal.
2. For towns with curbside collection, the average distance traveled by local collection trucks was estimated by assuming each truck carries ten tons of MSW and travels, on average, the distance from the town's approximate geographic center to the town's transfer station (if applicable) or directly to the disposal facility serving the town. For towns utilizing their own transfer station, it was assumed that waste is loaded into 20-ton tractor trailers for transfer.
3. For towns relying on drop-off centers, GHG emissions associated with residents' travel to drop-off centers were ignored. It was assumed that all MSW is transferred from the drop-off centers using 20-ton tractor trailers.
4. For the islands, it was assumed that waste is transferred by barge to either Woods Hole or Hyannis, from where it is transferred on 20-ton tractor trailers.
5. Estimated fuel efficiencies, capacities, and GHG emissions factors for each transportation method are shown below:

[8] ICF (2020). "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)." Prepared for the U.S. Environmental Protection Agency.

a. Collection and transfer trucks achieve a fuel efficiency of 6.5 miles per gallon (mpg)[9] and transport 10 and 20 tons of waste, respectively.

b. Barges achieve a fuel efficiency of 0.51 mpg[10] and transport 1,275 tons of waste per trip for an efficiency of 647 ton-miles per gallon[11].

c. Rail transport achieves an efficiency of 492 ton-miles per gallon[12].

d. Diesel fuel has a GHG emissions factor of 0.0117 metric tons of carbon dioxide equivalent (MTCO2e) per gallon of diesel fuel consumed[8].

5.1.2 Existing System (Baseline)

Annual GHG emissions from the existing system serve as the baseline for comparison to future options. Baseline GHG emissions were estimated based on assessing the existing decentralized system where each town is independently responsible for MSW disposal and provides services in accordance with the existing system and per-town tonnages described in the Task 1 memo. In brief, the existing system utilizes a combination of drop-off centers and small local transfer facilities to transfer waste under private hauling contracts. Most towns predominantly send MSW to SEMASS or the Crapo Hill Landfill, although the Bourne ISWM Facility currently serves Bourne and Falmouth and some towns send MSW to the Middleboro Landfill or other off-Cape landfills depending on hauler routing and schedules.

5.1.3 Options for Tipping at On-Cape Regional Transfer Stations

Geosyntec estimated the GHG emissions that would result from collection vehicles using the YTS and/or UCRTS facilities for regional tipping and transfer under a new centralized system. The analysis is based on estimating the volume of MSW from each sub-region of Barnstable County consistent with the map shown in Figure 5-1 overleaf (i.e., Outer/Lower Cape, Mid-Cape, and Upper Cape) as well as the islands. The approximate locations of YTS (green star) and UCRTS (red star) are also shown on Figure 5-1.

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[9] https://www.inlandtruck.com/blog/getting-best-mpg-semi-truck/

[10] Cape Cod Commission (2021). "Cape Cod Regional Greenhouse Gas Inventory."

[11] Texas A&M Transportation Institute (2017). "A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001 – 2014." Prepared for National Waterways Foundation.

[12] https://www.csx.com/index.cfm/about-us/the-csx-advantage/fuel-efficiency/#:~:text=The%202018%20CSX%20system%2Dwide,492%20ton%2Dmiles%20per%20gallon.&text=(3000%20tons%20x%20500%20miles,on%20a%20gallon%20of%20fuel.%E2%80%9D

Figure 5-1: Approximate Locations of On-Cape Transfer Stations

Assuming the average collection vehicle contains ten tons of waste (a conservative assumption, as many towns will likely continue to use larger 20-ton tractor trailers to haul waste to transfer stations), the approximate annual waste tonnage and annual truckloads for each sub-region and island are listed in Table 5-1 below.

Table 5-1: Waste Volumes and Collection Truckloads per Sub-Region/Island

Sub-Region	Total MSW Generation (TPY)	Annual Truckloads
Outer/Lower Cape	21,700	2,900
Mid-Cape	20,900	2,100
Upper Cape	23,500	2,400
Martha's Vineyard	5,400	600
Nantucket	11,400	1,200

Notes. Data for 2019. Truckloads assumed 10 tons/load and are rounded up to nearest one hundred loads.

The average distance traveled by collection trucks originating in Barnstable County and routed to either YTS or UCRTS was estimated by assuming each truck would travel, on average, the distance from each town's approximate geographic center to the transfer station in question. It is noted that waste would be transferred from the islands to YTS or UCRTS using a combination of barge and truck transportation, with different emission factors applied accordingly to each transfer portion.

5.1.4 Options for Out-of-State Transportation and Disposal

As outlined in Section 2, in all cases waste from the towns would be consolidated into railcars at YTS and/or UCRTS and transported by CSX rail to one of six candidate waste by rail landfills. Total haul distances to each landfill were shown in Figure 2-1. Minor differences in final on-Cape haul distances from YTS vs. UCRTS were ignored as being negligible in the context of the total haul distance.

5.1.5 Options for On-Cape Processing of Organics

Organics processing would have the effect of reducing the quantity of MSW delivered to YTS and UCRTS with subsequent reduction in the total annual tonnage transported by rail for disposal. This would reduce the overall GHG emissions associated with all options outlined above. Therefore, to account for on-Cape organics processing, the assumed quantity of organics diverted from the MSW disposal stream (see Section 3.1.1) was subtracted from the previously assumed totals and the GHG emissions associated with tipping, transportation, and landfilling recalculated accordingly.

As described in Section 3.2, two organics processing options were considered: backyard/community composting and decentralized organics processing. Both options assume that YTS and UCRTS are used for out-of-state transport of inorganic, non-compostable waste. For backyard/ community composting, it was assumed that there would be no GHG emissions associated with transporting or collecting organics. For the decentralized organics processing option, it was assumed that three composting facilities would be developed, each serving the Outer/Lower Cape, Mid-Cape, and Upper Cape subregion, respectively, as described in Section 3.2.2. It was assumed that each facility would be located at the geographic center of the subregion and that organics would be transported to it from the geographic center of each town within the subregion using 10-ton collection trucks.

GHG emissions associated with composting organic waste were calculated using WARM for both backyard/community composting and decentralized organics processing. For the latter, sizing and operational assumptions for each facility are listed in Section 3.2.2.

5.2 Results of Analyses

Annual estimated GHG emissions associated with each waste disposal option considered herein are summarized in Table 5-2 below. Detailed analyses are provided in Appendix 1. Emissions associated with disposal/processing are relatively low (and negative in some cases). Specifically, negative emissions indicate the following:

1. Landfilling: Avoided emissions from methane capture and flaring, avoided utility emissions from electricity generation due to LFGTE facilities, and carbon storage within the landfill (e.g., sequestering of plastics).
2. Incineration: Avoided landfill emissions and avoided utility emissions from electricity generation.
3. Composting: Avoided landfill emissions, increased soil carbon storage from applying compost to soils, and avoided emissions from production of synthetic fertilizers.
4. Anaerobic digestion: Avoided landfill emissions and avoided utility emissions from displacement of natural gas.

Positive and negative emissions can be considered as emissions above or below an internal baseline within WARM. In interpreting negative emissions in Table 5-2, therefore, it is the magnitude of differences between options that is important. For example, the expected GHG emissions from disposal/processing associated with decentralized composting (-6,080 MTCO2e) are 11,438 MTCO2e less than the existing system (+5,358 MTCO2e).

Table 5-2: Summary of Annual GHG Emissions from Different Options

Option	GHG from Transportation (MTCO2e/year)	GHG from Disposal/Processing (MTCO2e/year)	Total GHG Emissions (MTCO2e/year)	Reduction in GHG from Baseline (MTCO2e/year)
Existing System (Baseline)	294	5,358	5,652	N/A
Rail Transfer[1]				
YTS Only	1,299 – 2,588	1,197	2,496 – 3,785	1,867 – 3,156
UCRTS Only	1,315 – 2,604	1,197	2,512 – 3,801	1,851 – 3,140
YTS + UCRTS	1,248 – 2,537	1,197	2,445 – 3,734	1,918 – 3,207
On-Cape Organics Processing with Rail Transfer of Inorganics[2]				
Backyard/Community	901 – 1,829	-6,080	-5,179 – -4,251	9,903 – 10,831
Decentralized	952 – 1,880	-6,080	-5,128 – -4,200	9,852 – 10,780

Notes: (1). Ranges given for transportation reflect the different rail haul distances to candidate landfills, which varies from 560 to 1,200 miles as shown in Figure 2-1. (2). As GHG emissions from transportation and disposal are similar for all three waste-by-rail options, the effects of adding backyard/community composting or a decentralized composting program are assessed assuming transfer of residual inorganics using YTS + UCRTS.

6. SUMMARY AND CONCLUSIONS

Based on review of information discussed in this Report, the following major findings are identified for Tasks 2 and 3 of the Project.

6.1 Out-of-State Waste Disposal Options

Geosyntec's analysis indicates that using rail to transport MSW from Cape and Island towns to out-of-state landfills represents a viable long-term disposal solution with six waste by rail landfills identified that have direct CSX rail access or access via a short-line transfer. Each candidate landfill offers at least ten years of remaining permitted capacity, can readily accept an additional 85,000 TPY of incoming waste, and can manage the transportation logistics associated with transporting waste from Cape Cod by rail.

Geosyntec interviewed the private waste companies that operate these landfills to confirm information about their companies, the serviceability of CSX rail links to the landfills, and expected turn times for railcars. Overall, we are confident that these six landfills are realistic candidates for reliable and stable out-of-state MSW disposal. Therefore, should the County pursue out-of-state rail transfer and disposal contracts, it is likely that there will be several firms competing to take the waste.

6.2 On-Cape Organics Processing Options

Geosyntec's preliminary analysis indicates that processing of residential organics under a decentralized program in Barnstable County could eliminate up to 24,000 TPY from out-of-state disposal, helping alleviate some long-term disposal challenges faced by Cape and Island towns as well as improve overall waste diversion and recycling rates. CASP technology offers a reliable solution for organics processing, while other composting and AD technologies are available that would likely also be suitable. Notwithstanding, several issues will need to be overcome as part of implementing a successful organics processing system, not least the challenge of having households embrace the additional step of having to separate their organics for curbside collection or delivery to drop-off centers. Pushback against the higher costs for separate organics handling and processing should also be expected.

6.3 Tipping and Transportation Options

Geosyntec's site reconnaissance of the YTS and UCRTS facilities and review of their operating conditions and on-site storage capacity for railcars suggests that both facilities are viable options and could meet the requirements for out-of-state transfer of 85,000 TPY at a peak rate of 600 TPD. Both facilities are currently operational as rail transfer facilities with operating permits.

However, YTS will likely require a permit modification for higher operating throughput and operating UCRTS at a peak rate of 600 TPD without making upgrades and adding equipment and personnel could potentially put transfer operations at risk of slowdown or disruption. Thus, although developing UCRTS remains a viable standalone option for out-of-state MSW transfer, developing YTS appears to offer a more robust option. In terms of providing redundancy, the option of developing both transfer stations may be preferred.

Should an out-of-state transfer and disposal operation be pursued, coordination will be required with the current operators of both transfer stations regarding the end of their lease agreements on the facilities.

6.4 Environmental Performance

An assessment of the environmental performance of each option was presented in Section 5 of this Report. Based on review of the data in Table 5-2:

1. Without separation of organics for on-Cape processing, all three rail transfer options are roughly equal in terms of their environmental performance. Higher GHG emissions are associated with longer rail haul distances. Total GHG emissions for rail haul options are slightly lower than the existing system: if a closer landfill is selected, total GHG emissions would be about 2,500 MTCO2e/year, roughly 3,100 MTCO2e/year less than the baseline, whereas if a farther landfill is selected total GHG emissions would be about 3,800 MTCO2e/year, roughly 1,900 MTCO2e/year less than the baseline.
2. Including separation of organics would result in significantly improved environmental performance relative to the existing system and proposed waste-by-rail options. Total GHG emissions are estimated at about -5,200 to -4,200 MTCO2e/year, a reduction of 10,800 to 9,800 MTCO2e/year relative to the baseline. This could represent a nearly threefold reduction in total GHG emissions associated with MSW management.

Overall, waste-by-rail represents a slight improvement to the existing system in terms of GHG emissions, particularly if a closer landfill is utilized. Overall, however, the quality of LFG management and the existence of a well-run LFGTE system to utilize captured methane are significantly more important criteria for selecting a waste-by-rail site than distance from the Cape. Implementing on-Cape organics composting is recommended as a meaningful measure to reduce the towns’ GHG footprint for MSW management.

6.5 Next Steps

Further discussion of potential contracting mechanisms and a detailed analysis of costs associated with each option will be provided as part of the scope for Task 4, which represents the next deliverable for the Project.

Partnering with off-Cape towns could provide two main volume benefits. The first, is that additional steady volume will serve to smooth out the peak and low season volumes of the Cape towns, making the annual volumes easier to plan for logistically. This can also save money by reducing the number of rail cars needing to be stored during off-peak months and avoiding storage and fees associated with cars entering and leaving the system. The second benefit is that more volume may provide purchasing power to receive volume discounts. However, this is incumbent on the financial and operational considerations of the destination landfill at the time. There is no standard discounting within the industry or at certain price points.

7. REFERENCES

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Task 1 – Quantify and Characterize Cape Cod MSW, MSW Out-Of-State Disposal Cost/Benefit Analysis, Final Rev. 1 Memorandum prepared by Geosyntec Consultants dated 26 May 2021.

U.S. Environmental Protection Agency, Waste Reduction Model (WARM), www.epa.gov/warm.

APPENDIX 1 –
WARM Calculations
(see attachment)