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IMPROVING NON-HAZARDOUS SOLID WASTE DIVERSION, FOOD WASTE
NESDI #478

Jill Hamilton
Edwin Chiang

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Navy Environmental Sustainability Development to Integration Program

IMPROVING NON-HAZARDOUS SOLID WASTE DIVERSION

FOOD WASTE

NESDI #478

Guidance Document

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EXECUTIVE SUMMARY

The purpose of this guide is to provide information on how Navy installations can add food recovery to their existing waste diversion programs. This document describes the ways in which a typical installation would approach food waste separation and recovery efforts. Navy installations need to increase reuse and recycle of non-hazardous solid waste (SW) to meet diversion goals specified in the Department of Defense (DoD) Strategic Sustainability Performance Plan (SSPP) and in Executive Order (EO) 13514. These goals are: diverting at least 50 percent of non-hazardous solid waste by the end of fiscal year 2015 and increasing the diversion of compostable and organic material from the waste stream.

Food recovery is an EPA-recognized option to help maximize landfill diversion. Basic-level food recovery programs involve low-cost modification to daily practices, local pick-up infrastructure, and consumer training. More sophisticated programs operate on-site food waste processors, including grinders, mixers, compactors, bio-digesters, and composting equipment. In order to ensure both the success and the sustainability of a new program, the practices and equipment should be chosen so that they are easily adopted by Navy installations.

The overall goals of landfill diversion are environmental stewardship and compliance; however there is also the potential to save O&M expenses. While most of the Navy is recycling, its overall waste diversion can be further increased by food recovery. For example, landfill diversion results in immediate savings in tipping fee and food waste separation could easily increase this rate. There are also potential returns from options like composting and biodigestion.

Although food waste diversion is an excellent concept to implement, there are many limitations to consider for example economics. Understanding the limitations would help the site program manager select the appropriate technology or practices to use while creating a successful food waste diversion program. If the infrastructure setup, equipment, and labor costs greatly outweigh the benefits, the food waste diversion program would not be sustainable. Therefore, an initial cost analysis must be performed first to determine the viability of such a program.

Each installation needs to assess their resources and be selective of the options presented in this document. Because each situation is unique, the change in the diversion rate may differ significantly across Navy sites. The extent to which food separation may be adopted will be affected by the timing, availability of human and financial resources, and the command's competing priorities in environmental compliance.

Some Navy organizations will be better able to incorporate food recovery into their existing green programs and take advantage of its benefits. Not all of the practices and technologies discussed in this guidance document will be applicable to every Navy site. Recognizing the correct tools for handling food waste at each site is one of the main objectives for drafting this guidance.

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ACRONYMS AND ABBREVIATIONS

BMP	Business Management Practices
CNO	Chief of Naval Operations
DECA	Defense Commissary Agency
DoD	Department of Defense
EO	Executive Order
EPA	Environmental Protection Agency (United States)
EXWC	Engineering and Expeditionary Warfare Center
FRC	Fleet Readiness Center
ISWM	Integrated Solid Waste Management
MCAGCC	Marine Corps Air Ground Combat Center
MCB	Marine Corps Base
MSW	Municipal Solid Waste
NAS	Naval Air Station
NAVFAC	Naval Facilities
NESDI	Navy Environmental Sustainable Development to Integration
QRP	Qualified Recycling Program
SSPP	Strategic Sustainability Performance Plan
SW	Solid Waste
WTE	Waste-to-Energy
U.C.	University of California

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Thanks to Paul Brewer, Oliver "Rusty" Elam, and Wendy Zook at Naval Air Station Whidbey Island Recycling Center and John Lacy at NAVFAC Northwest for sharing information on their food separation efforts and for setting an example of the Navy's evolving effort remove food from the waste stream.

Thanks to U.C. Davis for sharing how their food separation was adopted to support on-campus organic farming and their food waste collection protocol.

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1.0 INTRODUCTION

1.1 Problem Statement

The purpose of this guide is to provide information on how Navy installations can add food recovery to their existing waste diversion programs. This document describes the ways in which a typical installation would approach food waste separation and recovery efforts. Navy installations need to increase reuse and recycle of non-hazardous solid waste (SW) to meet diversion goals specified in the Department of Defense (DoD) Strategic Sustainability Performance Plan (SSPP) and in Executive Order (EO) 13514. These goals are: diverting at least 50 percent of non-hazardous solid waste by the end of fiscal year 2015 and increasing the diversion of compostable and organic material from the waste stream.

Since 2005, the Navy's diversion rate has been between 32-40%; this includes paper, scrap metal, cans, plastics, glass, grass clippings and some food waste. To meet the SSPP and EO diversion goals the Navy needs to identify technologies and methods for diverting recyclable and compostable materials from existing solid waste streams. Due to the complex challenges of separating food waste, food waste is usually the last type of waste to be considered for diversion or recycling.

The United States Environmental Protection Agency (EPA) estimates that food scraps make up approximately 14% of the non-hazardous SW generated (See Figure 1). Solid waste characterization studies of Navy installations estimate that about 14-16% of the total waste stream is food, or 20-25% when it includes food-contaminated wastes, such as paper napkins and towels, beverage containers, cardboard containers, and paper packages. Diverting organic waste can increase the Navy's current SW diversion rate of 32-40% by 10-15%.

This guide will assist the Navy's effort toward increasing and improving the separation and handling of food waste. This project was funded under the Navy Environmental Sustainable Development to Integration (NESDI) program to provide a cost effective method for identifying, analyzing, and managing environmental constraints related to current and projected regulated impacts. The guide is written primarily for installations with existing food waste management infrastructure. In addition, it includes different food waste separation case studies conducted both within and outside of the DoD. By providing various examples, costs and lessons learned, Navy installations can improve or incorporate food waste separation into their own infrastructure.

1.2 Food Waste Sources

At Navy installations, the major sources of food wastes are the galleys followed by food courts, and the main break rooms at the larger office buildings. Most of the food waste remains mixed with municipal solid waste (MSW), which is delivered to transfer stations for basic sorting and then disposed in landfills. Because food waste does not get separated at transfer stations it must be separated upstream (on facilities where it is collected), or better yet, at the source (in the buildings where it is generated).

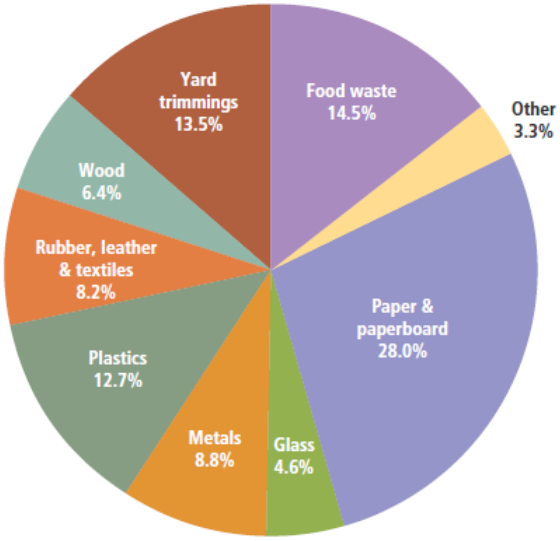

Figure 1. Total U.S. Municipal Solid Waste Generation (by material) in 2011 (before recycling).[1]The total U.S. MSW recovery in 2011 was almost 87 million tons. Figure 2 provides the percentages for the materials recycled. Food waste represents a very small portion of the materials currently recovered in the U.S.

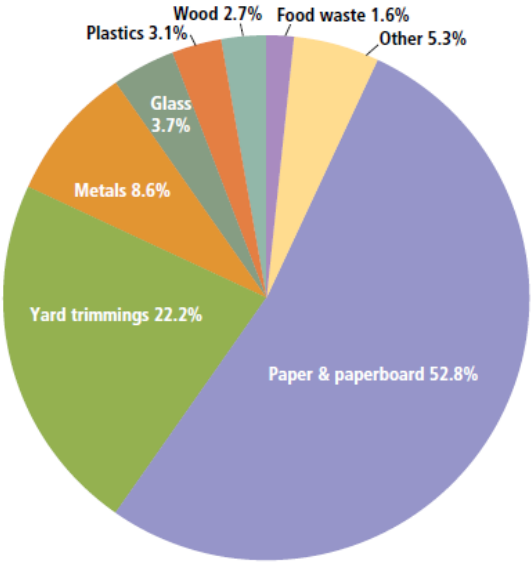

Figure 2. Total U.S. Municipal Solid Waste Recovery (by material) in 2011[1]

As shown in Figure 3, food waste is the largest component of post-recycling discarded waste material, at 21 percent. By increasing organic waste diversion, as directed by EO 13514, the Navy's diversion rate could potentially increase by 10-15 percent and help meet the 50 percent diversion goal.

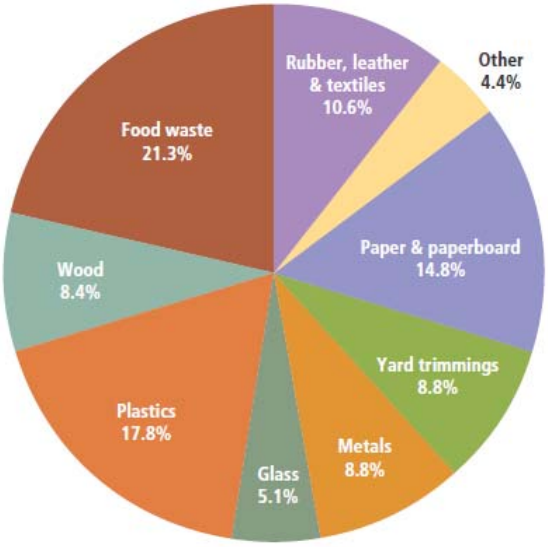

Figure 3: Total U.S. Municipal Solid Waste Discarded (landfill or incinerated by material) in 2011 (after recycling and composting)[1]

1.3 Benefits

In addition to the Navy's commitment to compliance with all applicable environmental requirements, they are constantly seeking ways to enhance their stewardship and sustainability efforts. Food waste recovery can help delay the exhaustion of landfill space and prevent the release of further greenhouse gases to the atmosphere. Currently, scrap food waste is a major source of landfill methane, and landfills are the third largest source of human related methane gas production in the United States. Seventeen percent (17%) of all methane emissions in 2011 were from landfills. Methane has an effect 23 times greater as a greenhouse gas than carbon monoxide.[2]

The most effective route for Navy participation is proactive involvement from existing programs such as recycling and green waste composting. For example, the food waste recovery and composting program at Naval Air Station (NAS) Whidbey Island is currently supported as part of its overall recycling program.

In addition to the Navy's legal obligation for environmental compliance, the Navy also benefits financially from food waste diversion. The tipping fee for waste disposal is charged per ton of trash weighed at the landfill and ranges from city to city. At Whidbey Island, WA, the current fee is $145 per ton of municipal solid waste while in San Diego and Whittier, CA it is $48 per ton and $40 per ton, respectively. When bases divert food waste, they pay less in tipping fees and have the potential to increase their landfill diversion rate by 10-15%. Along with food waste diversion, source reduction would also immediately decrease the Navy's spending. These savings would be realized immediately because the action to be taken is a change in practice, not the procurement of additional equipment.

2.0 EPA GUIDANCE, TECHNOLOGY, AND PRACTICES

2.1 EPA Guidance

The EPA has been maintaining comprehensive guidance on food waste diversion as well as post-collection processes to produce products with information for both waste management groups as well as consumers. Figure 4 represents EPA's preferred hierarchy of methods for managing food wastes and preventing them from reaching landfills. The figure shows that food waste entering landfills can be reduced without physically separating post-consumer food waste by implementing the methods in the top tiers of the pyramid. The "value" of food decreases from the top to the bottom of the pyramid.

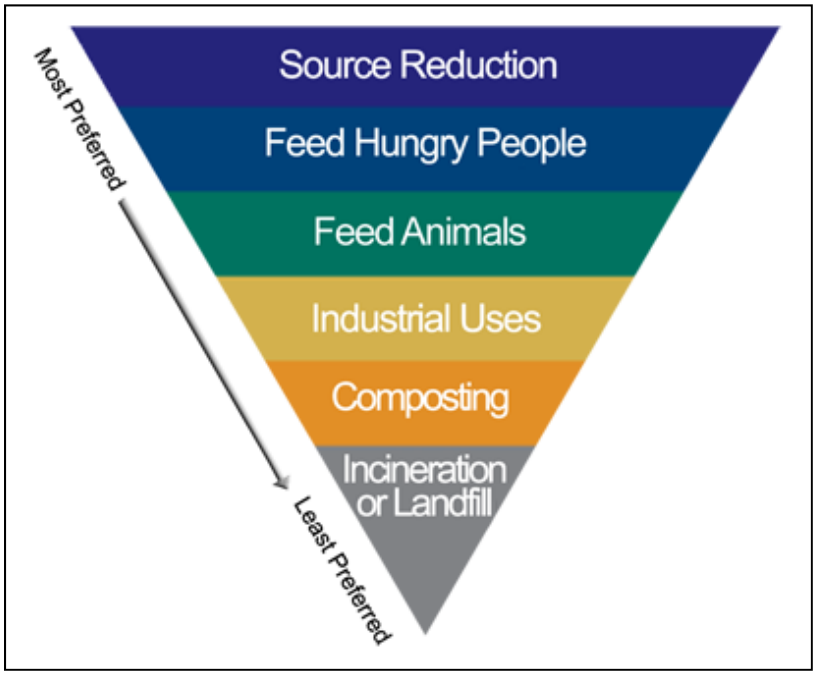

Figure 4: EPA's Food Waste Separation and Recovery Hierarchy.

As suggested by the relative size of the tiers, the most preferred diversion practice is source reduction to prevent the accumulation of leftover, uneaten food. In this management technique, the appropriate amount of food is purchased so there are fewer leftovers and less food that is thrown away. Maximizing the use of the techniques at the upper level of the inverted pyramid maximizes the value of food.

Table 1 explains each tier in greater detail, with examples to point out the expected differences from the conventional processes.

Table 1: EPA's Food Recovery Hierarchy Tiers Explained.

Tier	Examples of Changes in Practice	Infrastructure Supplements (Optional Equipment or New Technology)
Source Reduction	• Avoid preparing excess food by making better estimation of daily sales. • Food service education, for better food preservation and storage. • Consumer education to take closer to exact amount of food to be eaten.	• Food dispensers, self-service at the cafeterias and galleys. • Pre-order programs.
Feed Hungry People	Gather unspoiled, unconsumed leftovers in sanitary, food-grade containers for donation	Employee training to properly check for spoilage and package donation food. Disposable or reusable containers for transportation of food.
Feed Animals	Consumed, yet unspoiled food can be gathered to feed animals	Bins for transportation of food to farms. Trucks may be necessary if the receiving party won't pick up from the base.
Industrial Uses	Separate out fats, oils, and grease from other types of food waste for use in production of consumer products or conversion to energy.	Arrange for local vendors to haul the waste away for free, and maybe even receive payment.
Composting	Consumed and unconsumed food waste is composted either on-site or off-site.	On-site composting bins may need to be purchased, unless there are local donations. A specialized truck with a grinder attached may be helpful for transportation from the collection sites to the composting site.
Incineration or Landfill	This is the least preferred option, but also the default in case there are portions of waste that cannot be used at higher tiers.	Continue to have the difficult waste hauled away with a tipping fee, or purchase an incinerator or a thermo-catalytic converter. Running these machines onsite may help the economics. (This is an under-explored territory within the Navy).

2.2 Technologies

Navy installations that are interested in diverting food waste from the landfill must have an outlet for the separated waste, i.e. some place for the waste to go to other than the landfill. Many mature technologies exist that can process food waste, and the by-product of the food waste processing can be useful such as compost for agriculture or liquid effluent for irrigation. The food waste may be processed either on-site or off-site, depending on available space and funding. This section lists known technologies that can be used to process food waste. Some of these technologies have a large footprint, high capital, operation and maintenance costs while others do not. Section 4.0 provides a cost and footprint breakdown of the different technologies. Navy installations may select the treatment option according to their available resources, or seek private companies that specialize in food waste disposal.

The use of the technologies outlined below will depend upon the availability and amount of food waste at each installation.

2.2.1 Anaerobic Digester

Anaerobic digestion is the process where microbes breakdown biodegradable waste, such as food scraps, manure, and sewage sludge, in the absence of oxygen. This process produces biogas which can be captured and used as a source of clean energy. Waste mass is reduced and stabilized, and the remaining biosolids can be used as a soil amendment.

Anaerobic digesters are commonly used at wastewater treatment plants to treat sewage sludge prior to being hauled to landfills. Digesters break down sewage sludge at varying temperatures in an anaerobic environment and generate methane gas, which can be used to generate electricity. The retention time is generally between 14-20 days. Studies show that the combination of sewage sludge and food waste enhances the performance of the anaerobic digesters, so more sludge gets broken down and more methane gas can be harvested. Wastewater treatment plants are beginning to show interests in partnering with local universities and communities to start accepting their food waste. Preferably, the food waste would be physically broken down as much as possible prior to entering the anaerobic digester. The food waste can enter the digester via the sewer drain or by physically putting the food waste into the digester. This type of facility does require electricity, but the methane generated onsite can offset the energy usage.

2.2.2 Composting Technologies

Composting is an aerobic process where biodegradable material is broken down using bacteria to produce soil amendment. Organic wastes (e.g., food wastes, yard trimmings, manure) are combined into proper ratios in piles, rows, or vessels. Bulking agents (e.g., wood chips) are added to accelerate the breakdown of organic material. The final product, compost, is used as a soil amendment. Establishments that compost on-site avoid collection costs that generally represent the majority of waste handling expense.

2.2.2.1 Aerated Static Pile

Aerated static pile composting comprises forcing (positive) or pulling (negative) air through a compost pile. Agitation only occurs when piles are combined or moved to a different area for curing. Aerated static piles were originally conceived as a way to achieve pathogen reduction in biosolids composting. It is rare that aerated static piles are used to compost materials that need to physically break down (as well as biologically). That is because static piles are not turned frequently.

2.2.2.2 Windrow

Windrows require frequent turning and careful moisture and temperature control but are able to accommodate meat and grease. Windrow composting requires large open space and compost windrow turners, but generates a large volume of compost. The temperature of the windrows must be constantly monitored so the windrows can reach the optimum temperatures before being turned.

2.2.2.3 In-vessel

In-vessel composting is a moisture and temperature controlled system that can accommodate meat and grease as well as process larger amounts of waste in a smaller footprint. It uses the concept of a bioreactor, i.e. it involves mechanical, biological and chemical processes. The difference between an in-vessel composter and an anaerobic digester is aeration (i.e. in-vessel composters aerate the waste while anaerobic digesters do not). Composting is conducted in a controlled environment such as temperature, air-flow and a set carbon to nitrogen ratio, and microorganism is used to assist with the food degradation. The residence time is generally between 14-21 days. After 21 days, the compost is ready to be used as a soil amendment and is free from deadly pathogens. Figure 5 is an example of a type of in-vessel composter.

Figure 5: In-vessel Composter at NAS Whidbey Island.

2.2.2.4 Vermicomposting

Vermicomposting is composting food waste using worms, particularly red worms. This process is similar to the standard process of composting; however, red worms speed up the degradation process by eating the food waste. Meat and grease are not acceptable in vermicomposting systems.

The waste produced by red worms adds to the nutrients in the soil. Vermicomposting can be done on a large scale or a small scale. However, limitations for this process include:

- Maintaining neutral pH. When the pH becomes either too acidic or alkaline the worms may be harmed or killed. Wastes with high citric content are not recommended for placement in worm bins.

- Maintaining correct temperature. Most worms feed at temperatures between 55-80 °F; temperatures below 50 °F or above 86 °F can harm or kill the worms. Because of the temperature range it may be more suitable to vermicompost indoors. Also, to maintain these temperatures thin layers of material need to be added to the bin so the internal temperatures do not rise to the point of killing worms.

- Separating the worms from soil is labor intensive.

- Requires more space than a traditional compost bin. Several worm bins will be needed to obtain the same compost yield as from one traditional composting bin.

- Bedding must be provided to allow the worms to breed away from their food.

Note: To meet EPA standard for class A compost, the material must be heated to at least 132 °F and held for at least 72 hours, which will kill the worms. Therefore, vermicomposting is not a recommended method.

2.2.3 Dehydrator

This type of composter occurs within a container where the food waste is heated at high temperatures (180°F) and dehydrated. The duration varies depending on the type of waste but is usually no longer than 24 hours. The process does consume electricity to heat the waste and generally does not use enzymes, microorganism, or additives. The by-product is sterile soil amendment, or dried “char”, which is required to be tilled into the soil for curing. Benefits include as much as 90% volume reduction, one person operation, no water connection required and no addition of microorganisms.

2.2.4 Liquefying Decomposter

A liquefying decomposter is a machine that breaks down the food waste into liquid effluent. The effluent can be discharged into the sewer or be used in irrigation. Whether the effluent ends up at the wastewater treatment plant or in agricultural fields, both scenarios are beneficial. At wastewater treatment plants, the effluent, filled with nutrition, would enhance methane production at anaerobic digesters and in the fields the effluent would be a liquid fertilizer to the

crops. Commercially available liquefying food decomposters can turn food waste into grey water within 24-48 hours. This type of liquefying food decomposter discharges the effluent directly into the sewer. The capacity of the machine ranges from 600 pounds of food waste to 2,400 pounds of food waste. The decomposting machine does consume electricity and water; however, water consumption varies depending on the food waste characteristics. The machine operates by incorporating a mixer, water and proprietary microorganism chips. These microorganism chips are similar in size to woodchips but contain microorganisms designed to bio-degrade food rapidly. They must be maintained and replenished as needed. The end result is nutrient rich slurry that is discharged into the sanitary sewer system. The quality of the slurry depends on the feedstock i.e. the slurry can be thick or thin depending on the food waste that is fed into the machine.

2.2.5 In-sink Grinder

An in-sink grinder is an industrial-grade garbage disposal that can pulverize food waste prior to it entering the sewer. The ground up food waste can easily enter the wastewater treatment plants without clogging the pipes. This technology provides kitchen staff a convenient method in cleaning the dishes while disposing of the food scraps at the same time. Figure 6 is an example of a type of in-sink grinder.

Figure 6: In-Sink Grinder

2.3 Management Practices

Eighteen DoD and non-DoD facilities were interviewed for a comprehensive look at the food separation and disposal practices, including seven (7) Navy bases, two (2) Marine Corps bases and nine (9) public sites (universities and grocery stores). However, two Navy sites did not engage in food waste diversion. The findings are outlined below and include source reduction, bin systems and sink troughs. These types of equipment usually require minimal understanding of physical, chemical, and biological sciences and can be operated by non-technical personnel.

2.3.1 Source Reduction

Source reduction including tray-less dining is an indirect method to increase the food waste diversion percentage (see Appendix A for examples of calculating the diversion rate). Source reduction and tray-less dining reduce the amount of food waste produced, and therefore reduce

the amount of food waste being sent to the landfill (compared to before) and increase the diversion percentage.

Source reduction involves reducing the amount of food that is ordered from the food vendor to a level where there is minimal uneaten food left over. In addition, it includes practices that minimize the amount of food waste produced by consumers. This can be a difficult change. Traditionally, cafeterias order enough food to ensure no possibility for shortage. Donation and disposal may be more preferable for convenience, but source reduction can result in greater savings in both time and money. A facility interested in pursuing source reduction should consider the following strategies from EPA:

- **Conduct a Food Waste Assessment -** The first step in reducing food waste is to measure and track the amount, type, and reason for its generation. Knowing how much and why food waste is generated will help a business create targeted food waste prevention strategies. This baseline information also serves as a marker for measuring the diversion rate and change in spending.

- **Reduce Food Waste in the Kitchen:**

  ***Reduce over-purchasing of food* -** Create guidelines or implement a system to ensure that the amount of food ordered is the amount that is consumed. This could include a "just-in-time" ordering system or a new purchasing policy.

  ***Reduce prep waste and improperly cooked food* -** Look at production and handling practices and consider strategies for reducing prep waste including: improving knife skills of staff, purchasing pre-cut food, reducing batch sizes when reheating foods like soups or sauces and training staff to reduce the amount of improperly cooked food.

  ***Consider secondary uses for excess food* -** Leftover bread can become croutons, excess rice can become fried rice, leftover fruit can be a dessert topping, and vegetable trimmings can help form a base for soups, sauces, and stocks.

  ***Ensure proper storage techniques* -** In order to reduce spoilage, food products should be stored in proper conditions (e.g. temperature) and organized easily so that older products are used first.

- **Reduce Plate Waste -** Consumer kitchen waste includes all food wastes generated once the food reaches the customer. This includes food left uneaten by customers and garnishes.

  ***Modify menu to increase customer satisfaction and reduce food left uneaten* -** Food frequently left uneaten or sent back by customers can be identified by tracking wasted food. Based on this information, managers can modify the menu and better satisfy the customers.

  ***Change serving sizes and garnishes* -** Even small garnishes and improper serving sizes quickly add up to a significant amount of food waste. Strategies to reduce this waste include avoiding inedible or rarely eaten garnishes, reducing the scoop or

serving size while still satisfying a customer's appetite, and using an "ask first" policy for sides.

Encourage guests to order or take only the food they can consume - Food service managers can post informational signs at buffet-style food service venues that encourage customers to take only enough food to match their appetite. At Syracuse University, they implemented the “Taste Don’t Waste” test, which allows the students to try a sample of the food before taking the entire portion. The results showed that less food waste was created because the students would take what they would eat.

- **Tray-less Dining** - Universities with buffet-style dining noticed that many students put more food than they consume on their trays. Tray-less food service discourages consumers from taking more food than they can carry as well as dissuades consumers from returning back to the food station if they are not hungry. Universities found that students do waste less food with tray-less dining and they save water too. Some cafeterias with conveyor belts designed for return trays have to be retrofitted to take plates instead of trays. This concept can be applied at galleys with buffet-style dining, and reduction in food waste produced is expected. However, before this technique is implemented, consumers’ morale may be affected and should be considered.

2.3.2 Bin System

Food waste is most commonly collected at kitchens, cafeterias, and grocery stores with bins. The bins or collection containers are customized to the sites’ individual capacities as appropriate. Smart container choices help minimize the capital equipment costs as well as operation and maintenance costs. They are typically heavy-duty plastic, and their sizes can range from small for offices and other places where food is not a major trash item, to a system of multiple containers to accommodate the kitchen, cafeteria and commissary. The containers are placed in convenient locations so users do not have to travel far distances unless public safety regulations prohibit otherwise. At the galley or dining facilities, the staff would dispose of the food waste from meals to prevent contamination of non-compostable material. At other places, the consumers are directed by posters and signs to dispose of the waste in specific containers. Such posters and signs are usually placed near the bins with photos of what are and are not acceptable. While bio-degradable bags are available to keep the bins clean, many places do not use bio-bags to reduce costs and instead clean the containers daily. Figure 7 is an example of a bin system set up at a cafeteria (UC Davis, 2013).

Figure 7: Bin Setup in Food Court at U.C. Davis

The example at UC Davis is a sophisticated version of the bin system because the food waste is collected for on-site composting. This kind of bin system is best at places where most of the patrons at its cafeteria are reasonably aware of which bin the trash would go into.

Figure 8 is an example of a bin setup in an administrative setting at UC Davis. Notice that the bins are smaller and labeled properly. At the end of each day, the janitor collects the compost bio-bags on each floor and puts them in a larger dumpster container. Because the new work of emptying the compost bin daily was not a large change to the workload, the work schedule was not significantly disrupted.

Figure 8: Bin Setup in Office Building

In the kitchen, large, ruggedized trash bins are used to collect unmarketable produce at the commissary or leftovers at the dining facilities. Fresh produce may be tossed into the trash bins without bio-bags due to the cleanliness of the waste. For collecting meat, bio-bags are recommended. At NAS Whidbey Island, consumers at the galley turn in their food trays to the kitchen staff, and the staff dumps the food waste directly into the trash bins. The bins were lined to reduce the frequency of cleaning them, but at UC Davis the bins were not lined. However, they were cleaned on a daily basis. The trash bins should have wheels so they can be easily transported from the kitchen to outside where they are picked up.

2.3.3 Sink-Trough

U.C. Davis has a creative method of separating and collecting food waste from plates at the dining facilities. After the consumers return the plates, the kitchen staff uses sink hoses and washes the food inside a trough-like sink. The sink is large and long enough to have multiple staff wash dishes at the same time. The food waste is washed off the plates and into a food trap at the end of the sink. The food trap then is emptied into a nearby trash bin. This is an easy and efficient method and can be adopted at any facility. Figure 9 is an example of a sink-trough.

Figure 9: Sink Trough

2.4 Case Studies

Eighteen DoD and non-DoD facilities were interviewed for a comprehensive look at the food separation and disposal practices, including seven (7) Navy bases, two (2) Marine Corps bases and nine (9) public sites (universities and grocery stores). However, two Navy sites did not engage in food waste diversion. Additionally, web searches and market surveys were conducted for additional identification of food diversion technologies or implementation strategies.

While this Guidance Document cannot guarantee case studies to match every Navy installation exactly, it provides a collection of information from which an appropriate protocol can be customized.

2.4.1 DoD Food Waste Separation Practices

Feasibility of food waste separation depends on circumstances at the site e.g. economics, available funds, existing infrastructure and available outlets to dispose of the food waste. Some Navy sites are better suited than others. Fifteen percent (15%) of Navy installations compost materials, usually green waste. It is estimated that only two or three of these installations that compost incorporate food waste. NAVFAC EXWC compiled food waste diversion practices

from seven DoD facilities including a visit to NAS Whidbey Island to have a visual observation of their food waste diversion process.

2.4.1.1 NAS Whidbey Island

At NAS Whidbey Island, food waste diversion was a development of Navy Whidbey Island Recycle, a part of the base's Solid Waste Management Program. In 1990, the base landfill was closing and the recycling program was initiated to avoid the tipping fees and other inconveniences of transporting the waste to an external landfill. The base took a comprehensive approach (i.e., reduce, reuse, and recycle) with the goal of achieving zero waste, from source-reduction levels to waste-to-energy initiatives. In FY 2012 NAS Whidbey's diversion rate was 69%. NAS Whidbey Island separates its food waste at the commissary and the galley and began a small-scale separation program in some offices, such as the Fleet Readiness Center (FRC).

Commissary. The staff collects unwanted fruits and vegetables and tosses them in bins outside the building, see Figure 10. With the exception of bins for meat scraps, the food bins are unlined and located at least 30 feet from the building, due to health and safety concerns. In the meat department, food bins are lined with bio-bags to keep the bins cleaner.

Figure 10: Commissary Food Waste Collection.

Galley. The food bins are lined and located inside the kitchen, where the staff disposes of pre-consumer and post-consumer food waste, see Figure 11. Food is only collected when food processing and clean-up occurs. All bins are lined with bio-bags to address safety and health concerns. The staff fills the bins to the highest level prior to removal from the kitchen. The frequency of removal is dependent upon the completion of the processing or clean-up operation, and may only be partially full.

Figure 11: Galley Food Waste Collection.

Exchange Food Court. In the Food Court, customers must separate their food waste into designated bins. The only training the customers receive is in the form of signs posted over the collection bins, see Figure 12.

Figure 12: Food Court Collection and Signage

Office Buildings. Recycling at office buildings is slowly starting to be implemented. Getting the individual workers to properly dispose of their waste is most challenging. Currently, FRC is the only office building that separates its paper and food from the main waste stream (see Figure 13). FRC was not mandated to recycle its waste but initiated this program on its own.

Figure 13: Paper Towel and Food Waste Collection.

Food Waste Collection. All food waste is scheduled to be picked up in a tipping/mixer truck by the recycling staff on Mondays, Wednesdays, and Fridays (see Figure 14). The staff reported that collection is the most time consuming part of the process. Also once a year, the staff inspects the food waste to search for contamination e.g. gloves, plastic, etc. The food waste is inspected only once a year because the staff does not anticipate a high level of contamination. If they see contamination, they inform the management at the commissary and galley to provide refresher training to their staff.

Figure 14: Tipping Truck and Mixed Food Waste

Composting. All diverted food waste at NAS Whidbey Island is composted at a 1:1 ratio of carbon to nitrogen. The food waste is mixed in the collection truck for 15 minutes prior to being emptied into the in-vessel composter. The in-vessel composter uses an automated computer system for controlled composting. NAS Whidbey Island owns and operates six composters: two for bio-solids and four for food waste. Each composter is a large holding tank with sensors that monitor the temperature of the waste during the decomposing process. The temperature must be held at 131°F for 72 hours to kill bacteria and subsequently at 104°F for 14-21 days to kill vectors. If the temperature/duration criteria are not met, then the composter is investigated to determine the problem and the time cycle is reset. Once complete, the compost is placed in a pile on a concrete pad outside the compost facility. The Qualified Recycling Program (QRP) sells the

compost for $18/yd^3 to anyone with base access. Occasionally, when there is an abundance of compost, the QRP conducts direct sales.

2.4.1.2 Other DoD Sites

Table 2 lists how other DoD facilities conduct food waste separation. The solid waste managers at these facilities were e-mailed a questionnaire in which they responded to or information was collected through phone or email conversations. No visits were conducted at these sites.

Table 2: DoD Sites Engaged in Food Separation and Waste Diversion

Installation (Location)	Location of Food Waste Diversion	Diversion Practice/Technology
Naval Base Coronado (San Diego, CA)	Galley	Bin System Staff
Naval Station Newport (Newport, RI)	Galley	Drums Staff
Naval Air Station Jacksonville (Jacksonville, FL)	Galley	Signs "Take What You Can Eat"
NAVFAC Washington (DC)	Hospital Galley	12-35 gal. Toters Staff
Naval Station Everett (Everett, WA)	Commissary Galley Fire Department Pierside Plaza Commons Child Development Center	Bin System Staff
MCAGCC Twenty-Nine Palms	Commissary Mess Hall	Dehydrating Composter Liquefying Decomposter Staff
MCB Camp Pendleton	Mess Halls	Dehydrating Composter Staff

The Defense Commissary Agency (DECA) conducted a pilot test of a dehydrator at the commissary at Marine Corps Air Ground Combat Center (MCAGCC) 29 Palms, where 3,100 pounds of food waste created 150 pounds of reusable bio-solids.[3] In addition, the Marine Corps Regional Food Service Command purchased dehydrators for MCAGCC 29 Palms and MCB Camp Pendleton for use in their mess halls. However, there were issues with maintenance of the equipment and the use of the bio-solids, which were being disposed of as solid waste. In addition, the amount of dehydrators required for all of the installation's food waste makes it economically unfeasible.

Currently, MCAGCC 29 Palms is in the process of conducting a pilot test of a liquefying decomposter for use at the mess hall. Documentation on the use of the technology has not been received to date.

2.4.2 Non-DoD Food Waste Separation Practices

2.4.2.1 University of California at Davis

The University of California at Davis (U.C. Davis) is a leading example of environmentally proactive colleges within the United States. The school began diverting food waste to support on-campus organic farming and it now diverts nearly 98% of its pre-consumer and post-consumer food scraps at its dining halls. Their accomplishment results from campus policies and education such as source reduction, proper disposal, tray-less dining, employee training in separating different waste streams, supply management (reduced packaging materials, including elimination of plastic bags), and utilizing biodegradables utensils at special events. Their ultimate goal is to reach zero-waste status. NAVFAC EXWC visited the university to learn more about its food waste diversion program and to observe the process. While the majority of the diverted food waste originates from the dining halls, food waste is also collected at retail stores, cafes, and some administrative buildings.

Dining Halls. At the dining halls, food waste separation occurs behind the scenes in the kitchen, and both pre-consumer and post-consumer wastes are separated. When customers finish eating and return their food plates on the conveyor belt, dining staff quickly wash the plates with a hose in a trough-like sink to remove the food from the plates. The food waste is washed into a catchment at the bottom of the sink. Once collected, the food waste is placed in a pulper to remove as much liquid as possible. Afterwards, the waste is dumped into a nearby trash bin. The trash bin is emptied as needed into a compactor located outside the dining facility. The trash bin is not lined but is pressure washed each day.

Food Courts/Coffee Houses. In dining facilities, trained staff separate pre and post food waste. In Food Courts and Coffee Houses, customers must separate their food waste into designated bins. The only training the customers receive is in the form of signs posted on the bins and nearby walls, and therefore the contamination rate in the post food waste was higher. This reduces the diversion rate. Signs show the consumers what should be placed in each bin (See Figures 15-16).

Figure 15: Examples of Signage for Food Waste Separation.

Administrative Buildings. Not every administrative building separates its food waste, as food waste separation is still a pilot project in these types of buildings. For those offices that do, workers throw away their food waste into a bin designated to collect the waste. Each floor has its own bin and the bin is lined with a compostable bag. At the end of each day, the custodian collects all the compost bags from each floor and throws them in a larger trash bin. Once a week, the trash bin is collected and brought to the nearest compactor. The compactor receives food waste from both office and dining facilities. It is also emptied once a week.

2.4.2.2 Other Sites

Information on how other public facilities separate their food waste is listed in Table 3. Information about these sites was found on the Internet. No site visits were conducted.

Table 3: Non-DoD/Public Facilities Engaged in Food Separation and Waste Diversion

Site	Location of Food Waste Diversion	Diversion Method
Purdue University	Dining Hall	Dish washing trough/bin system
Whole Foods (Reno, NV)	Produce	Bin System
Hilton San Diego Bayfront	Dining Hall	Bin System
Syracuse University	Dining Hall	Bin System, Taste Don't Waste
University of Texas	Dining Hall	Source Reduction, tray-less Dining
Carson City Costco	Produce	Bin System
City of San Francisco	Commercial/Residential Buildings	Bin System
City of Portland,OR	Residential Buildings	Bin System

The City and County of San Francisco
San Francisco's Mandatory Recycling and Composting Ordinance require businesses and residents to separate their recyclables, compostables, and landfill trash. The law also sets the goal of 100 percent waste diversions by 2020.

Their comprehensive program is formed through partnerships with local food banks, haulers, and end users. At least 400 tons of food scraps are composted every day. Collection service is provided weekly and residents are charged a fee for extra trash but not green waste and recyclables.

City of Portland, OR
Portland developed a composting operation where both food scraps and yard debris are mixed together in their yard debris container. Portland's website provides information on the type of materials allowed and methods for collecting the waste. To reduce vectors associated with food recycling, the yard debris container is picked up on a weekly basis.

3.0 ASSESSMENT OF TECHNOLOGIES AND MANAGEMENT PRACTICES

Food has a variety of compositions, and separation by components can result in higher-value recovery. Figure 17 illustrates how mindful separation at the early stages of disposal can result in higher value products and minimized time and staff effort to divert the waste from landfills. For example, oil is traditionally collected in a separate collector at kitchens not only to prevent improper disposal (i.e., sewage system) but also to make it available as raw materials (i.e., for local biofuel producers).

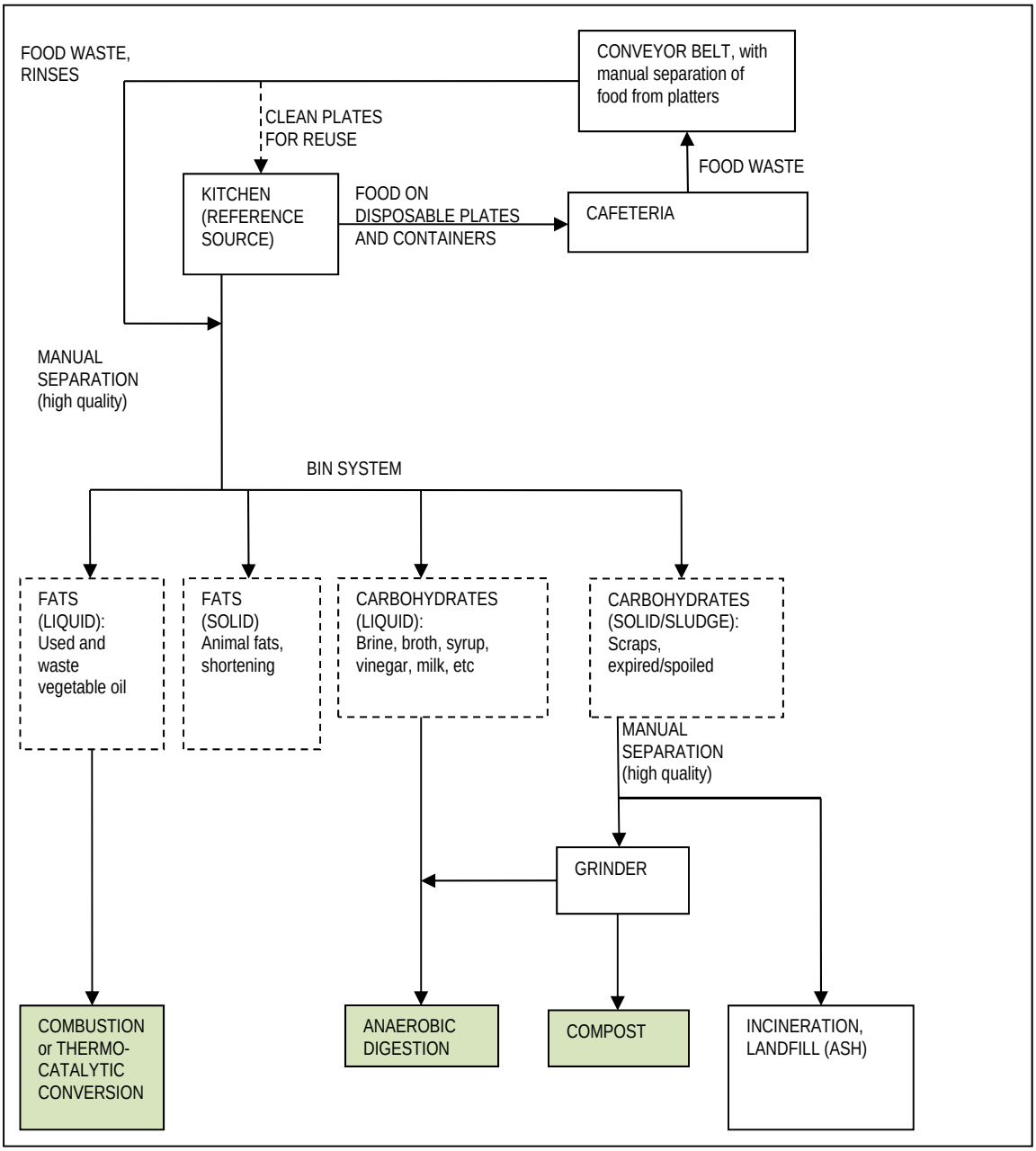

Figure 16: General Food Separation, Based on Chemical Composition.

3.1 Technology and Separation Methods Summary

These technologies and separation methods have their advantages and disadvantages as shown in Table 4.

Table 4: Advantages and Disadvantages

Technology	Advantages	Disadvantages
Aerated Static Pile	• Can process high volume of compost	• High capital cost and may require permanent structure to be put in place • High energy cost • Long processing time (2 – 8 weeks) • Less control of end product quality • Odor and vector control issues • Not easy to mobilize or move equipment to a different location • Not easy to expand facility • Permitting requirements
Windrow	• Low capital cost • Low energy cost • Uses natural passive aeration which needs to be turned regularly • Easy to mobilize or move equipment to a different location • Easy to expand facility	• Requires large area of land for windrows. • Long processing time (3 - 6 months) • Less control of end product quality • Less temperature control • Odor and vector control issues • Permitting requirements
In Vessel	• Requires small land area • Easy to expand facility • Low energy cost • Short processing time (3 to 4 days) with 10 days of curing time • Provides consistent sanitized end product • Good temperature control • Good vector and odor control • Fairly easy to mobilize or move equipment to a different location	• High capital cost • Permitting requirements
Anaerobic Digester	• Reduces emissions of landfill gas • Source of energy (methane capture) • Digested materials used as soil amendment (based on feedstock purity)	• High capital costs • Permitting requirements • Need to ensure feed stock purity • Limited control of end product quality • Odor control issues

Technology	Advantages	Disadvantages
Dehydrator	• Placed at source of food waste • Short processing time	• Limited amount of waste allowed to be processed • Expansion requires additional purchase, increasing capital costs • Use of dried "char" needs processing, often landfilled
Liquefying Decomposter	• Placed at source of food waste • Short processing time • Effluent is discharged into the sewer • Not labor intensive	• Limited amount of waste allowed to be processed • May require large amounts of water use
In-sink Grinder	• Placed at source of food waste • Assists in increasing methane gas production at wastewater treatment plant • Not labor intensive	• Reduction of wastewater flows and loads by Municipalities by reducing the amount of in-sink grinders • Waste becomes part of the sewage sludge disposal and may be landfilled

Separation Practices	Advantages	Disadvantages
Source Reduction	• Saves money • Prevents food waste generation • No "by-product"	• Requires upfront planning and data collection • Can be labor intensive
Bin System	• Low cost • Training of staff is not difficult with a low contamination rate	• Inclusion of post consumer food may have high contamination • Clean bins regularly to reduce/ eliminate odor and vector control issues.* • Additional labor cost to clean and swap out bins. • If required, use of bio-bags is costly • Requires more frequent pickups

* Recommend the use of a power washer to clean the bins with a drain specifically for collection of water run-off.

3.2 Limitations

Although food waste diversion is an excellent concept to implement, there are many limitations to consider. Limitations range from economics to delivery destination to knowledge, cultural behavior, and physical space. Understanding the limitations would help the user select the appropriate technology or practices to use while helping create a successful food waste diversion program. Not all of the practices and technologies discussed in the guidance will be applicable to every interested Navy site. Recognizing the correct tools for handling food waste at each site is one of the main objectives for drafting this guidance.

3.2.1 Economics

If the infrastructure setup, equipment, and labor costs greatly outweigh the benefits, the food waste diversion program would not be sustainable. Therefore, a cost analysis must be performed first to determine the viability of such a program. To minimize costs, changes to the infrastructure as well as some of the tools for implementing the separation should be sized appropriately during the planning stage. For example, compostable bags can be expensive when ordered in large quantities, so its necessity should be rated against other options, such as no bags or ordering just enough bags to keep the program active for a few months at a time.

3.2.2 Food Waste Destination

The final destination of the food waste is another limiting factor. On-site or off-site options depend on the base's resources. For example, NAS Whidbey Island had the resources to create the infrastructure on-site; however, other bases may not. The location of the composting center off-base should not be too far, otherwise the benefits of food waste diversion would be negated by transportation costs. However, if the food waste cannot be processed on-site or nearby off-site, then food waste separation is not viable.

3.2.3 Permitting

Installations considering on-site food recovery methods must liaison with their State and/or local regulators, to identify the proper permits required prior to the purchase of food recovery equipment. Each state/locality will differ, so limit the discussion to general permitting considerations. For example, due to permitting restrictions, Naval Station Great Lakes was unable to install an in-vessel compost unit on-site.

Additionally, permitting or testing requirements must be met to use or sell compost end products. Compost end products need to comply with Code of Federal Regulations (CFR) 40 Part 503 (c) Class "A" Exceptional Quality (EQ). This designation allows for unrestricted use of the compost end product (e.g., land cover and garden) on-site.

3.2.4 Food Donation

In October 1996, The "Bill Emerson Good Samaritan Food Donation Act" (Public Law 104-210) makes it easier for businesses to donate to food banks and food recovery programs. It protects donors from liability when donating to non-profit organizations and protects donors from civil and criminal liability should the product donated in good faith later cause harm to the needy recipient.

Installations seeking to donate food should check local health codes to ensure that specific regulations detailing how excess food needs to be packed and transferred, including the correct temperature to maintain the food. Often installations, to reduce liability issues and the packaging requirements, only donate canned and boxed food when available.

3.2.5 Personnel Training

Lack of food waste separation knowledge is another noteworthy limitation. Since the patrons of dining facilities are not expected to have any prior knowledge of food separation practices, there would be an adjustment period where the patrons may accidentally put the food waste in the incorrect bin—for the sites that require the patrons to separate the food waste. Adaptability of food waste separation is dependent on the facilities' ability to collect and transport the food waste away from the consumers. Because of negative features associated with food waste, such as unpleasant odors and health concerns, many consumers may find it difficult to become proactive about handling food waste longer than needed. Most consumers today find it more convenient to dump food waste along with other trash. Prompt collection of food waste, however, helps the consumers overcome this discomfort.

3.2.6 Space Requirements

Lastly, another limitation for food waste technologies is the amount of space required. Table 5 lists the physical limitations of the technologies and practices. Those considering about diverting their food waste need to consider the available space they have and how much space the technology uses.

Table 5: Physical Limitations.

Method	Location	Footprint (ft^2)
Food Tracking (Source Reduction)	Galley	1
Tray-less Dining (Source Reduction)	Galley	N/A
Taste Test	Galley	N/A
Anaerobic Digester	Outside	130,600+
In-vessel Composter	Outside	32-320
Windrow	Outside	2,000+
In-sink Grinder	Kitchen	7
Vermicomposting	Office	15+
Dehydrator	Outside	12.5
Liquefying Decomposter	Kitchen; Outside	12-29
Bin System	Anywhere	2.5
Sink Trough	Kitchen	15

3.2.7 Cost of Implementation

The cost of implementation can be minimized by planning ahead and customizing to avoid over-sizing or under-sizing the required equipment pieces. Since food waste collection alone does not require any innovative technology, most of the tasks can be performed by general personnel. Table 6 provides implementation costs, yearly costs and life span.

Table 6: Implementation Costs

Method	Unit Capital Cost	O&M Cost/Year-Unit	Life Span
Food Tracking (Source Reduction)	$3,600 (training, installation and first year fees)	$300/month + Labor	N/A
Tray-less Dining (Source Reduction)	Varies	None	N/A
Taste Test	No Cost	None	N/A
Anaerobic Digester	$6-90M	$34-90/ton	15 years
In-vessel Composter	$10,000-$80,000	Labor	15 years
Windrow	$25,000-$100,000	$8,000 + Labor	20 years
In-sink Grinder	$1,000+	$1,000	15 years
Vermicomposting	$20/lb +$100/container	Labor Intensive	Indefinite
Dehydrator	$37,000	$4,000	20 years
Liquefying Decomposter	$900-$1,500/month (lease only)	Included in lease	20 years
Bin System	$70/container	Varies (Depend on whether compostable bag was used and number of bins)	20 years
Sink Trough	$400	None	20 years

4.0 FOOD WASTE DIVERSION RECOMMENDATIONS

Every Navy activity will need to assess its waste management priorities, available resources and existing infrastructure to determine whether it can support food recovery as part of its landfill diversion effort. As mentioned earlier, economics is the primary hurdle to any food waste separation program.

Food waste separation and recycling, as with any sustainable waste remedy, is intrinsically a community effort. Early recognition of existing opportunities to work with neighboring vendors and donation efforts will assist with program longevity. Any food waste collection program will require setting up designated bins at the disposal locations and providing a suitable means of transporting the food waste off of the site (i.e., a collection truck with a knowledgeable driver). Training is required for staff, and the infrastructure should be designed to minimize consumer training. The success of a food waste program will depend on its adaptability and economic and political sustainability, especially for programs with larger collection systems that are more financially burdensome to implement and tear down.

The extent of food waste separation and whether the site will perform some treatment of recovered food waste is the site's decision, and, the level of participation is flexible beyond the infrastructure of food waste bins. Each site will need to assess their resources and be selective of the options presented in this document. Therefore, the change in the diversion rate may differ significantly across Navy sites. The extent of adopting food separation will be affected by the timing, availability of human and financial resources, and the command's competing priorities in environmental compliance.

The following steps should be taken by any installation preparing to begin collecting and treating food separately from the rest of the waste stream:

1. Determine if the food waste will be processed on-site or off-site. If neither is viable, then food waste separation is not an option.

2. Assess amounts and quantity of feedstocks available. Locate sources of food waste and rank them by volume generated.

3. Identify goals/scope of the program.

    a. Will the feedstocks be separated or mixed?
    b. Will the food waste be incorporated with yard trimmings?
    c. Will this only include large waste generators, what is the limit, will it be widened to include smaller generators at a later date?
    d. Are donation programs available?
    e. Is the only goal to increase the diversion percentage, or are there other considerations such as removing materials from entering the landfill or reducing costs?

4. Contact the responsible personnel at the highest sources and find out current methods for food waste diversion. Get the easiest participants first such as commissaries, galleys and food service operations and ensure participation.

5. Determine the best technology for implementation, based on the available feedstocks. The chemical environment can determine if composting or other better methods are available. Chose the method that is compatible with already established systems.

    a. Collection and processing methods/costs.
    b. Markets and uses for any product developed.

6. Identify any permitting requirements (air/water) for any technologies to be implemented.

7. Make the program simple, easy and as convenient as possible. Color coded bins and pictorial graphics can help accomplish this.

8. Determine what training or additional tasks are required to implement

    a. Find out whether food service personnel can agree to extra tasks, such as full-service disposal from tray piles.
    b. Determine facility's users/clientele training or instructions required for proper disposal.

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GLOSSARY OF TERMS

Activity	A unit, organization, or installation that performs a function or mission.
Composting	The controlled process for managing the degradation of organic materials which is biologically broken down into a useful product such as mulch or a soil amendment
Discards	The municipal solid waste remaining after recovery for recycling and composting. These discards are usually combusted or disposed of in landfills, although some municipal solid waste is littered, stored, or disposed of on site, particularly in rural areas.
Disposal	The management of solid waste through landfilling, incineration, or transformation at permitted solid waste facilities.
Diversion (Solid Waste)	An activity to divert solid waste from landfill disposal or incineration, including reuse, donation, recycling, and composting/mulching. Diversion activities must be in compliance with all applicable DoD, DoD Component, Federal, State, and local requirements. Waste to energy recovery is not considered diversion.
Diversion Rate	The rate at which non-hazardous solid waste is diverted from a disposal facility. Disposal facilities include landfills (both solid waste and inert) and incinerators. Composting, mulching, recycling, and donation are generally accepted waste diversion methods. The diversion rate equals: $\frac{R}{R+L} * 100 = diversion\,rate\ (percent)$ R = amount (in tons) of non-hazardous solid waste (including recycled construction and demolition debris) that is composted, mulched, recycled, reused, donated, or otherwise diverted from a disposal facility. L = amount (in tons) of solid waste (including landfilled construction and demolition debris) transferred to a disposal facility.
DoD Component	Consists of the following: Army, Navy, Air Force, Marine Corps, Coast Guard (which operates as a Military Service in the Navy), Defense Agencies, and DoD Field Activities (which can include other integral DoD organizational entities established to perform a government function).
Energy Recovery	Steam or electrical energy produced from solid waste used as a fuel in a waste to energy plant. All incineration, including energy recover, is counted as disposal in diversion rate calculations.
Sustainable Acquisitions	Purchasing products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. Sustainable Acquisitions is also known as Green Procurement, Affirmative Procurement, or Environmentally Preferable Procurement.

Food Waste	All animal and vegetable solid wastes generated by food facilities resulting from the storage, preparation, cooking, and/or handling of food.
Food Waste Assessment	A method that measures and tracks the amount, type, and reason for the food generation. Waste logs, tracking software, or landfill characterizations can be used to measure the food waste. This assessment serves as a baseline information for changes in your diversion rate and spending.
Integrated Solid Waste Management	A comprehensive approach to managing non-hazardous solid waste that encompasses waste prevention, recycling, composting, and disposal programs. Through ISWM, DoD Components seek to determine the most cost effective, energy-efficient, least-polluting ways to deal with the various segments of, and the items typically found in an installation's solid waste stream.
Installation	A Navy or Marine Corps base of operations composed of a number of Navy or Marine Corps activities, units and commands, located on the property of the host activity. Installations may also have several tenants that may or may not be located on site.
Organic Waste	Solid waste originating from living organisms, their metabolic waste products, and/or petroleum. The waste is biologically decomposable by microbial and fungal action into the constituent compounds of water, carbon dioxide, and other simpler organic compounds.
Recovery	Materials removed from the waste stream for the purpose of recycling and/or composting. [NOTE: Recovery does not automatically equal recycling and composting. For example, if markets for recovered materials are not available, the materials that were separated from the waste stream for recycling may simply be stored or, in some cases, sent to a landfill or incinerator.]
Recycling	A series of activities, including collection, separation and processing, by which products or other materials are recovered from the solid waste stream for use in the form of raw materials in the manufacture of new products other than fuel for producing heat or power by combustion.
Source Reduction	Effecting changes in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce the amount or toxicity before they are discarded.
Waste Characterization Study	A study that identifies the constituent materials that compose the solid waste generated. It should be statistically representative and should, ideally, represent seasonal variations. The constituent materials should be identified by volume (percentage in weight, or its volumetric equivalent), material type, and source of generation (which includes residential, commercial, industrial and other sources).

APPENDIX A
DIVERSION CALCULATION EXAMPLES

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DoD SW Metric. The non-hazardous solid waste metrics are defined in ODUSD memo of 12 October 2004, subj: Revised Pollution Prevention and Compliance Metrics. The equation for diversion rate is:

$$\textit{Percent Diversion} = \frac{\textit{Tons Recycled + Composted + Other Select Waste Diverted}}{\textit{(Tons Recycled + Composted + OSW Recycled) +Incinerated + Landfilled + OSW Disposed + Oils(waste-to-energy)}} \textit{ x 100\%}$$

where "Oils(waste-to-energy)" is considered "disposed" for purposes of the DoD SW metric.

CALCULATING THE DIVERSION RATE.

Provided are scenarios of how processes and technologies affect the diversion percentage, using a simplified equation of the DoD SW metric:

$$D = \frac{R}{R + L}\ x\ 100$$

D = Diversion percentage
R = Amount recycled
L = Amount sent to the landfill or incinerated

For the following examples, the initial numbers of R=500 tons and L=1000 tons are used.

$$D = \frac{500}{500 + 1000}\ x\ 100 = 30\%$$

<u>Example 1</u>: Source reduction, tray-less dining, in-sink grinder, and liquefying decomposter all decrease the amount of food waste landfilled. If 100 tons of food waste are not disposed in the waste stream, the new diversion rate is:

$$D = \frac{500}{500 + 900}\ x\ 100 = 35.7\%$$

For in-sink grinders, food solids become part of the wastewater sludge. If the installation has a wastewater treatment plant and dispose of the sludge material in the landfill, then the diversion rate will not change.

<u>Example 2</u>: A composting operation both increase the amount recycled and reduce the amount landfilled. If 100 tons of materials are sent to be composted, the new diversion rate is:

$$D = \frac{600}{600+900}\ x\ 100 = 40\%$$

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