Federal Aviation Administration

Recycling, Reuse and Waste Reduction at Airports

A Synthesis Document

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- San Diego International Airport (SAN)
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- Yeager Airport (CRW)

I. INTRODUCTION

Sustainability

1. **Brundtland definition - meeting the needs of the present without compromising the ability of future generations to meet their own needs.**
2. **ACI definition (developed by the airports) – a holistic approach to managing an airport so as to ensure the integrity of the economic viability, operational efficiency, natural resource conservation and social responsibility (EONS) of the airport.**

Over the past several years, the Federal Aviation Administration (FAA) has been encouraging airport sponsors to incorporate sustainability in airport planning, design, and operations. Sustainability has been defined to include the principles of economic growth, environmental stewardship, and social responsibility.[1] Current FAA programs that support sustainability include Airport Noise Compatibility Planning, the Voluntary Airport Low Emission Program, Environmental Management Systems, and most recently Airport Sustainability Planning. In our continuing efforts to assist airport sponsors in incorporating sustainability into airport planning, design, and operations, the FAA has decided to provide specific guidance to airports in two key focus areas: programs to encourage recycling, reduction and reuse of materials, and programs to encourage airports to reduce their energy consumption

The FAA has compiled this synthesis document, or "one-stop-shop," for airport sponsors to use as a resource when contemplating an airport recycling, reduction, and waste reuse program to further their waste minimization initiatives. Specifically, this guidance is designed to provide recommendations on what things to consider and steps to establishing a recycling program at an airport to divert municipal solid waste (MSW) from the landfill. Although recycling of MSW is the focus of this document, other non-MSW waste streams are discussed which may require special considerations with respect to regulatory compliance. There is a special emphasis on construction and demolition waste since this is a big component by weight and volume of waste generated on an airport.

The document includes lessons-learned and case studies from airports around the country that not only address best practices in recycling, but also in the areas of reuse and waste reduction via "green" procurement programs. Although recycling of MSW is the focus of this document, other non-MSW waste streams are discussed for completeness since they may be a significant portion of the waste generated at an airport and may require special considerations with respect to compliance. And finally, the document provides a list of resources for the user since the market for recyclables is ever changing and these resources can be used to keep the user up to date with the most current information available.

A. Types of Waste Encountered at an Airport

Federal, state, and local agencies regulate different types of waste based on what the waste contains. In general waste from airports can be divided into seven types of waste: (1) municipal solid waste (MSW); (2) construction and demolition waste (C&D); (3) green waste; (4) food

[1] http://www.epa.gov/oecaerth/cleanup/revitalization/er3/benefits.html

waste; (5) waste from aircraft flights (deplaned waste); (6) lavatory waste; (7) spill cleanup and remediation waste; and (8) hazardous materials. Each is described below.

1. *Municipal Solid Waste* (MSW) consists of everyday items that are used and then discarded, such as product packaging, furniture, clothing, bottles, food scraps, and newspapers.

2. *Construction and Demolition Waste* (C&D) is generally categorized as MSW. However, as it can be a major component of airport waste, it has been separated into its own category in this document. C&D waste is any non-hazardous solid waste from land clearing, excavation, and/or the construction, demolition, renovation or repair of structures, roads, and utilities. C&D waste commonly includes concrete, wood, metals, drywall, carpet, plastic, pipe, land clearing debris, cardboard, and salvaged building components. In some instances, C&D waste may be subject to special requirements (e.g., tar impregnated roofing materials, asbestos containing building materials, etc.).

3. *Green Waste* is categorized as MSW and is also referred to as yard waste. Green waste consists of tree, shrub and grass clippings, leaves, weeds, small branches, seeds, pods and similar debris generated by landscape maintenance activities.

4. *Food Waste* is food that is not consumed or is the waste generated and discarded during food preparation activities. Food wastes are also considered part of the MSW waste stream.

5. *Deplaned Waste* is a specific type of MSW that is removed from passenger aircraft. These materials include bottles and cans, newspaper and mixed paper, plastic cups and service ware, food waste, food soiled paper, and paper towels. Waste that comes off the airplanes after flights can represent 20% of an airport's total municipal solid waste stream. The composition is roughly 30% each of paper waste, compostable food material, and non-recyclable materials, with the balance consisting of cups and beverage containers.

In the U.S., waste from international flights, except Canada, needs to be processed separately as the waste can potentially introduce plant pests and diseases. International waste is governed by the United States Department of Agriculture and must follow the handling procedures found in the Manual for Agricultural Clearance.

There are three approved methods for managing international waste: incineration to ash, sterilization, or grinding and discharge into an approved sewage system. Often, third party ground handling companies or flight kitchen operations manage this waste. Listed in the Manual for Agricultural Clearance are approved airports that can handle and dispose of international waste. Airports that are not on the list must deliver their waste to the nearest approved facility. For example, international flights that arrive at John Wayne Airport (SNA) transport their waste to Los Angeles International Airport (LAX) for treatment in autoclaves where sterilization is performed per USDA rules. The waste is then turned over to a waste hauler for disposal at a landfill. Many airports are prohibited from incinerating waste due to air quality regulations.

6. *Lavatory Waste* falls under the category of special waste and is generated when the lavatory tanks of the airplanes are emptied via hose and pumped into a lavatory service vehicle,

which can be either a self-powered truck or a lavatory cart pulled by a tug. After the aircraft's lavatory tanks are emptied, they are refilled with a mixture of water and a disinfecting concentrate, commonly called "blue juice." The lavatory waste removed from the aircraft is transported to a triturator facility, generally located airside, near airline operations, for pretreatment prior to discharge to the sanitary sewage system and publicly owned treatment works (POTW).

Lavatory waste, which contains chemicals ("blue juice") and potential enteric pathogens, can present risks to the environment and human health if not handled properly. Therefore, caution must be taken to ensure that releases of lavatory waste do not occur during the transfer process, which can result from either equipment failure (leaking values or hoses, etc.) or operator error.

7. *Spill cleanup and remediation waste*s are another type of special waste. These materials are generated during cleanup of spills and/or the remediation of contamination from various types of sites on an airport (e.g. storage tanks, oil and gas production, vehicular leaks, spills from maintenance activities, etc.). Care must be taken to ensure that these types of waste materials are not co-mingled with other waste streams and that storage and disposal procedures comply with applicable regulatory requirements.

8. *Hazardous Waste* must be handled in accordance with stringent federal regulations. Wastes designated as "hazardous" are covered by regulations outlining legal handling, treatment or disposal. Hazardous wastes are either specifically "listed" in the regulation (40 CFR 261.31-.33), or are ignitable, corrosive, toxic or reactive (as defined in 40 CFR 261.21 - .24). For details, see the Resource Conservation and Recovery Act ("RCRA") and its amendments and the regulations 40 CFR Subtitle C, Parts 260–270.

Hazardous Waste Case Study
St. Paul International Airport (MSP)

Hazardous wastes most often seen in the aviation industry include:

- **solvents**
- **caustic parts washes**
- **heavy metal paint waste and paint chips**
- **wastewater sludges from metal etching and electroplating**
- **unused epoxies and monomers**
- **waste fuels (including sump fuel or tank sludges) and other ignitables**
- **unusable water conditioning chemicals**
- **illegal dumping of containerized chemicals**
- **contaminated sludge in GA aircraft wash rack oil/water separators**
- **nickel cadmium (ni-cad) batteries**
- **waste pesticides**

The EPA developed less stringent regulations for certain hazardous waste, known as *universal wastes*, set forth in 40 CFR part 273, the Universal Waste Rule. If handled in a responsible method prior to legal recycling, these wastes are less heavily regulated. This rule provides a set of streamlined regulations to reduce the regulatory burden by allowing longer time for the

storage of the wastes, reduced record-keeping requirements and consolidation off-site without a permit.

Universal wastes are:

- ✓ Generated in a wide variety of settings other than the industrial settings usually associated with hazardous wastes;
- ✓ Generated by a vast community (typically greater than 1,000 sources);
- ✓ May be present in significant volumes in non-hazardous waste management systems unless measures are made to separate out these recyclable wastes.

Federal and state regulations govern the collection and management of these widely generated wastes, thus facilitating environmentally sound collection and proper recycling or treatment since economical recycling options exist for most of these wastes. These regulations also encourage the development of municipal and commercial programs to reduce the quantity of these types of wastes going to landfills. States can modify the universal waste rule and add additional universal waste(s) in individual state regulations, so the exact regulations for the applicable state should be consulted.

Universal Wastes include:

- **Batteries;**
- **Aerosol cans;**
- **Pesticides;**
- **Mercury-containing devices (such as mercury thermostats);**
- **Mercury-containing lighting (such as fluorescent bulbs); and**
- **Electronic devices and components (such as computers and monitors).**

B. Sources and Pathways of Airport Waste

For the millions of passengers who travel by air, airports are simply places where they get a boarding pass, go through security, grab a drink or a meal, queue and board the plane, and then take off down the runway. Even those who work at an airport may not see the full scope of activity buzzing around the complex facility. Each airport activity has its own set of actors, resource requirements and waste stream. Any plan to implement a recycling program at an airport must consider all of the activities and waste streams at the facility, even if the program is phased in gradually one or two activities at a time. The major activities should be analyzed in the context of their location, the context of what tasks are being performed, and what wastes are being generated. Below is a breakdown of the principal activities at each location as well as a description of the waste that is generated.

Terminals: The terminal is the heart of an airport complex and normally has the biggest concentration of people, which can translate into the biggest concentration of waste. The terminal houses not only the ticket counters and gates, but also restaurants, shops and restrooms that are frequented by passengers and employees of airlines and the airport. In addition, many terminals are large enough to have office space and break rooms for airline and airport personnel. As of the varied operations, the types of waste produced at a terminal are also varied, and include food, paper, plastic (in many forms), aluminum cans, restaurant grease and oil, universal wastes (electronics, light bulbs, batteries) green waste (from lawn care), general trash and deplaned waste from aircraft.

Airfields: The airfield features the runways and taxiways that allow aircraft to take off, land and go to and from the terminal. With such limited and transient activities, the character of waste produced at airfields is also limited and consists mostly of rubber from aircraft tires (runway rubber) and green waste.

Aircraft maintenance hangars: In the hangars, aircraft are subjected to the repairs and maintenance that are necessary for the safety and smooth operation of such large, complex pieces of machinery. In addition, airlines have aircraft ground service equipment (GSE) that need to be serviced as well. Servicing equipment results in a number of predictable types of waste, such as oil, grease, certain hazardous chemicals, universal waste (batteries, electronics, light bulbs), wastewater, plastic and vehicle waste such as tires and fluids (brake, transmission, etc.). These hangars also typically have office space where office waste is generated (see offices description below).

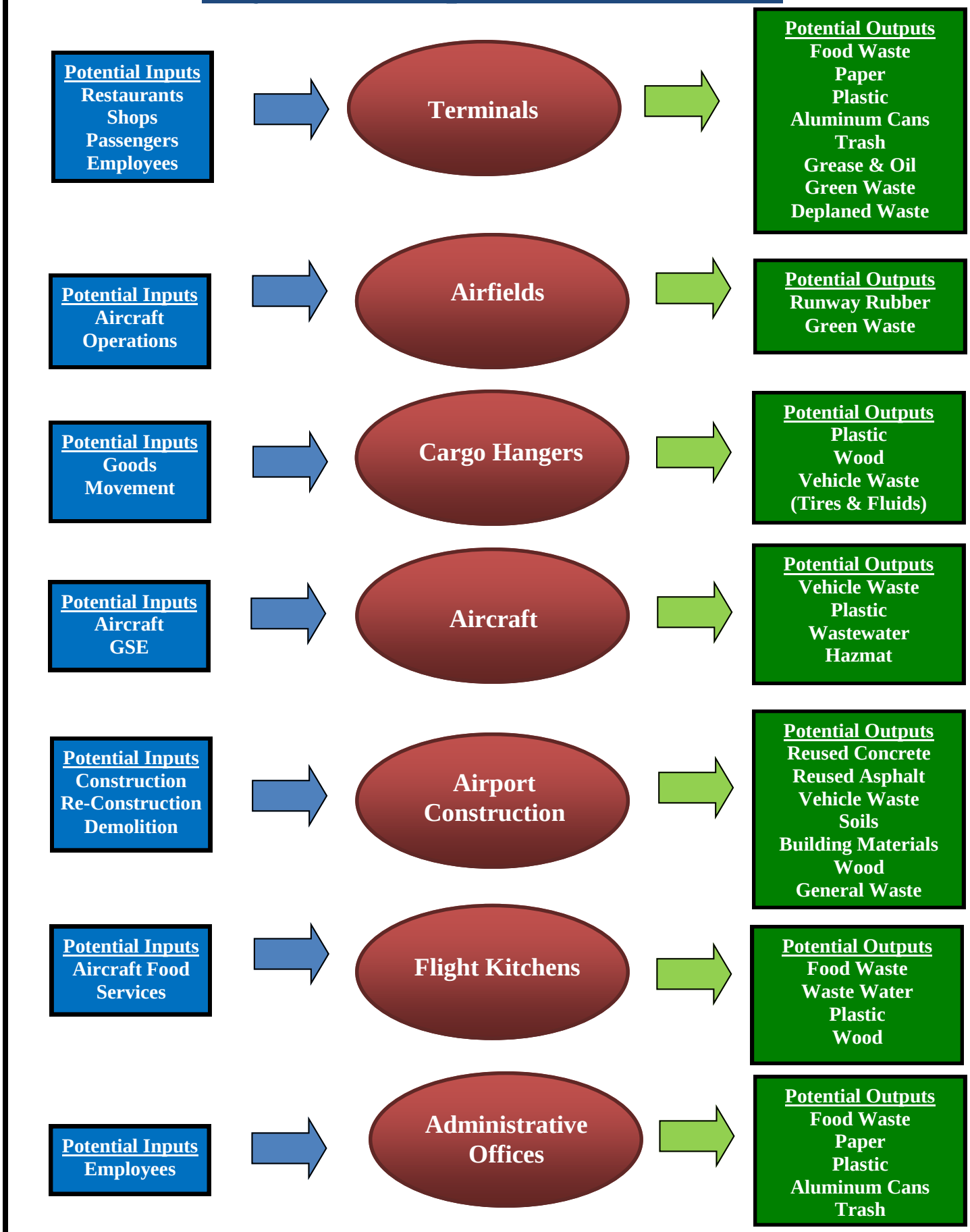
Cargo hangars: At all but the smallest airports, cargo being transported by air is loaded and offloaded and temporarily stored in hangars, and those hangars have equipment to move large heavy pallets. Waste from the cargo hangar will include tires, fluids from equipment, universal wastes (light bulbs, electronics, and batteries), wooden pallets and plastic packing material.

Flight kitchens: The food that is served on passenger airplanes has to be prepared, packaged, staged, and loaded onto the aircraft. During these phases, several types of waste may be produced, such as food, wastewater, plastic (of various types) and wooden pallets.

Offices: All airports have office space for airline and airport employees, as well as government representatives, and large airports may have multi-story office buildings. These offices yield waste streams typical of all office operations: paper, toner cartridges, universal wastes (batteries, light bulbs, and electronics), plastic, aluminum cans, food and general trash.

Airport construction projects: Whether they are large or small, all airports have construction needs from time to time, which can involve demolition, renovation or new construction. The waste products from construction are different from the normal day-to-day waste streams and thus require special attention, as will be discussed later in this paper. Types of waste that can arise from construction activities are concrete, asphalt, building materials, wood, soil, construction equipment waste and regular trash.

Any Town Airport Waste Streams



II. ESTABLISHING AN AIRPORT MUNICIPAL SOLID WASTE RECYCLING PROGRAM

Although airports throughout the United States have made efforts in recent years to increase recycling and minimize MSW, much work remains to be done. Undoubtedly, there are formidable challenges involved in setting up effective waste minimization and recycling programs at airports, but significant improvements can be made through a comprehensive analysis of the current systems in place, a frank assessment of constraints, and development of a clear plan of action.

Until recently, most airport recycling programs have focused primarily on maximizing the amount of recyclable materials removed from the waste stream. While this is important from both environmental and economic perspectives, a broader view is also necessary. Rather than focusing exclusively on extracting recyclables out of the waste stream, large organizations are now finding ways to minimize the overall waste stream up and down the value chain, thus influencing material management for better environmental and economic results. Similarly, a successfully executed airport recycling/waste minimization program has the potential to positively impact airport tenants, customers and the community at large.

The EPA provides a best practices overview regarding establishment of a recycling/waste minimization program at an airport as well as an overview of wastes typically generated at airports.[2]

A. How to Establish an Effective Airport Recycling/Waste Minimization

A successful long-term airport recycling program is the result of careful planning, precise execution, and continual testing and improvement. Using examples from the experiences of airports around the country, along with input from the Environmental Protection Agency (EPA), ten primary steps have been identified to design and implement an effective airport recycling/waste minimization program. While the problem of effective recycling/waste minimization at airports is universal, each airport faces a unique set of problems depending on its individual region, unique geography and society. Therefore, while some general practices are applicable to all airports, some solutions discussed may only apply to a particular airport or region.

10 Steps to Design and Implement an Effective Airport Recycling/ Waste Minimization Program

1. Commitment from Management
2. Program Leadership
3. Waste Identification
4. Waste Collection and Hauler
5. Waste Management Plan Development
6. Education and Outreach
7. Monitor and Refine
8. Performance Monitoring
9. Promote Success
10. Continuous Improvements

1. Commitment from Management

In order for a recycling program to be successful, management has to support the program. Management will need to understand the benefits of implementing a recycling program. Management will also need to be updated with successes to ensure their continued support.

[2] http://www.epa.gov/osw/conserve/rrr/rogo/documents/airports.htm

2. Program Leadership

A recycling coordinator should be designated who will be responsible for overseeing the recycling program. The coordinator will work with individuals from every sector of the airport to design and implement the program. They will also help to encourage participation and train and educate tenants, concessions and the public. In addition, the coordinator would be responsible for monitoring the recycling program and reporting to management.

3. Waste Identification

Waste Audit Case Study:

- **Los Angeles International Airport (LAX)**
- **Portland International Airport (PDX)**
- **St. Paul International Airport (MSP)**

Prior to developing a recycling/waste minimization plan, it is imperative to understand what waste is generated by which stakeholders, how much is collected, and where collection takes place at the airport. Examining both qualitative and quantitative data is essential and provides a baseline necessary for measuring future progress. Proper waste assessments should be based on the size of the airport, specific knowledge of airport operations, and include a detailed analysis of the waste stream, the program goals, and available resources, both at the airport and local recycling capabilities. The waste audit can also provide a baseline for future comparisons and for identifying new recycling opportunities.

Primary approaches to understanding the generation and flow of waste at an airport is a waste audit and include:

- Examination of Records
  - Waste hauling and disposal records and contracts
  - Supply and equipment invoices
  - Other waste management costs (commodity rebates, container costs, etc.)
- Facility Walk-Through
  - Qualitative waste information through observation of staff and customers and first-hand observation of waste handling practices to understand waste handling practices and how waste flows through an airport
  - Understanding waste pickup and hauling practices and how waste flows through an airport
- Waste Audits
  - Collection and analysis of the types of waste produced at the airport

Waste Assessments should include:

- Identification of what can and cannot be recycled in the region.
- Locations in the airport that generate waste.
- Types of wastes generated in each area, such as paper, scrap metal, plastic, etc.
- Identification of which materials that can be reduced, reused, and recycled
- Quantity of waste generated by each area of the airport (airlines, administrative offices, enplaned and deplaned passengers, concessions, etc.).
- Commodity rates for recyclable materials.
- Expenses for processing recyclables
- Costs for hauling, disposal and labor of landfill bound waste.

The most comprehensive and resource intensive way to assess waste stream composition, opportunities for waste reduction, and capture of recyclables is through a waste audit or material sort. To be successful, a waste audit must be a well-organized process that explicitly measures the quantity and types of

wastes generated. It provides a "point in time" snapshot of the waste stream of an organization and a reference point that provides information about current waste practices and how they can be improved. At an airport, a variety of waste, generators, receptacles and collection systems may be evaluated to assess specific waste streams.

4. Waste Collection and Hauler

Once you understand what is in your waste stream, it is important to gauge the potential markets for the materials that could be potentially recovered from it. One of the frustrating things about recycling is that the markets for secondary materials fluctuate, particularly for waste paper and cardboard. Proximity to glass recycling facilities can effect whether there is even a market for recovered glass. This market variability makes it difficult to establish recycling standards that are appropriate nationwide. However, there are a few materials that generally have some value in all markets, such as aluminum cans. Local waste haulers will know which materials can be cost-effectively recycled in your area.

Waste collection and choosing a waste hauler will be dependent on your area and what works best at the individual airport.

a. MSW Waste Collection

There are different options for collection systems depending on the local recycled materials market and the unique needs of each airport. Each system has advantages and disadvantages. Markets, material commodity values, local and regional frameworks, and types/availability of haulers should be examined before the system is created.

- *Separate stream recycling* requires airport travelers and tenants to place different materials in separate bins. The most common version of separate stream recycling is one bin for containers (plastics bottles, aluminum cans, and glass bottles) and another bin for paper. This ensures that material collection maintains a high level of quality, improving market returns for most materials.
- *Commingled recycling* allows airport travelers and tenants to place all recyclable materials in a single bin. The material is sorted later, usually at the materials recovery facility. This method can lead to lower quality material, particularly for paper and may not be available in some regions.
- *Post-collection separation of ALL materials*, known as "Mixed Waste Processing", allows airport travelers and tenants to dispose of recyclables and trash in the same receptacle. All material is sorted later. This process is labor-intensive and removes responsibility from individual generators.

Multiple studies have shown that public area waste collection at airports best achieves desired results of proper sorting and minimal contamination in recycling and waste streams when collection containers are paired in a "buddy system" containing paired recycling and landfill waste bins. Top-facing images and restrictive lids help to educate busy travelers to properly segregate and place materials and reduce contamination. Given the right visual cues and a simple, paired waste/recycling approach, public area collection can successfully contribute to an effective waste minimization program.

Different areas within the airport facility can have different collection strategies. The decision about what type of collection system is best for a facility or for specific areas requires an understanding of passenger and employee behavior and the value of the recyclables if co-mingled or separated. The waste identification process described above can help inform decisions about the best collection method.

In addition, compactors can be of value for reducing the amount of floor or ramp space needed for waste and recyclable collection. Again, the facility constraints and layout, value of the commodities, and nature of the waste generated from the collection area are instrumental input for making informed decisions about whether compactors make sense or not. For new additions to a concourse or terminal building or for new construction, it is imperative that the discussion about whether to include compactors or not should take place during the initial planning discussions.

b. Waste Hauler

Choosing the appropriate hauler and Material Recovery Facility (MRF) is an important component of an airport waste minimization and recycling program. There may be multiple options depending on the geographical location, and contracts and services may be bundled or separate.

Generally, two main systems of waste hauling contracts are available at airports; however a combination of the following systems may be appropriate for larger airports. Individual waste hauling contracts for each tenant represent a decentralized system, while airports that choose to handle all waste together represent use of a centralized system. When circumstances allow, many airports opt for a centralized waste management system, as it simplifies the collection process and allows for added efficiencies. A centralized system requires only one site for bins or collection, and this central collection area may be used for all tenants. Size considerations and volume of collection may warrant the use of decentralized system of waste collection; however, efficiencies may be gained by establishing a "hub and spoke" approach to a decentralized collection (multiple centralized collections) that could mimic many of the benefits of a single centralized collection.

In addition to the two main systems, there is an emerging strategy of Resource Management Contracting which compensates waste contractors for development of the collection system and performance in achieving the waste reduction goals rather than the volume of waste disposal (EPA reference).

There is no "right" choice for a hauler. An optimal hauler will be chosen depending on the specific needs of each individual airport. Generally, the hauler chosen should present the right balance of cost with the service necessary to achieve the recycling/waste minimization goals of the program. There are various levels of service that can be provided, and haulers may vary based on cost, customer service, environmental impact, and many other factors. It is important to point out that municipal governments may have contracts or policies in place that dictate specific requirements not addressed herein. The airport sponsor should check with the local solid waste division within his/her respective county to inquire about any local requirements.

5. Waste Management Plan Development

In developing the waste management plan, consider who the essential stakeholders are, characteristics of waste at your airport, and waste reduction strategies that could be implemented. This document outlines some common challenges when implementing a recycling program (see below).

a. Who are the essential stakeholders?

There are a number of essential stakeholder groups to consider when creating an airport recycling program. The implementation of a successful program should directly address each of the following groups, taking into account the individual needs and challenges of each when developing the program.

Essential Stakeholders

- Passengers passing through public areas, parking lots, garages, curbside pickup and drop off areas, restrooms, holding areas, and food courts
- Tenants such as businesses, airlines, and concessions (including taxi, hotel, rental cars, flight kitchens, and other industries that operate at the airport)
- Airline employees (including ground crew, cabin cleaning crew, catering);
- Employees of airport authorities, government offices, business agencies, etc.
- Maintenance operations and support facilities
- Contractors of the airport and its tenants, including aircraft cleaning and service, janitorial services, waste haulers, and construction contractors
- City or County solid waste management.

b. Waste Reduction Strategies

Waste reduction minimizes waste that would otherwise wind up in a landfill or disposed of in some other fashion that is environmentally undesirable. Reduction of a waste or a waste stream can come in different forms including waste redirection, repurposing, reuse, separation, or other means to lessen the volume of the waste stream or amount of waste. Reduction can best be accomplished when the total composition of an airports waste stream is analyzed in its entirety. Anything that moves material away from the landfill or some other disposal option is a positive move towards reduction.

i. Municipal Solid Waste General

Methods to reduce waste generated by the airport rely on contractual requirements. Examples include

- Requiring the vendor to package waxes, cleaners and other airport custodial products in refillable containers that can be accepted back by the manufacturer for reuse;
- Contract requirement for acceptance by the manufacturer of the airport's specification paints of any paint waste, which can be mixed into new paint batches;
- Contractual requirement to reduce packaging of products bought in bulk by the airport; and

- Requirements that concessions use compostable plates, plastic ware, and other high use items.

Airports undertake a number of measures for reduction of waste. To reduce the weight of trash, travelers at San Francisco International Airport (SFO) are asked to empty their water bottles in a receptacle prior to passing through the Transportation Security Administration (TSA) check points where liquid in drinking water bottles is prohibited. The collected water is then directed down a sink drain instead of being added to the other regular trash reducing the weight of the trash. When the weight of trash is reduced, it is less costly to dispose of. That also translates into less energy used to dispose of water weight in the trash waste stream. For example, some airports have constructed pre-security liquid collection vessels so that fluids from portable drinking containers can be emptied prior to disposing or recycling the bottle. This type of system helps to maintain the integrity of the recyclables and reduces the weight of the trash.

Liquid Waste Case Studies:

- **Oakland International Airport (OAK)**
- **Portland International Airport (PDX)**
- **San Francisco International Airport (SFO)**

Food and Restaurant Case Studies:

- **Denver International Airport (DIA)**
- **John Wayne Airport (SNA)**
- **Minneapolis Airport (MSP)**
- **Philadelphia International Airport (PHL)**
- **San Francisco International Airport (SFO)**

Some airports are using trash compactors to reduce the volume of the waste. Yet others are using composting for green waste and food waste. Compositing uses aerobic decomposition to degrade organic material. The compost product can then be used as a soil amendment.

Small-scale compositing operations can take place on site, though regulatory requirements vary from one jurisdiction to another for this activity. Commonly, green waste destined for further processing is hauled to a compost facility that can handle large quantities of this material, producing a more consistent compost product, while complying with all local and state regulatory and permitting requirements.

Pallet Case Study:

San Diego International Airport (SAN)

Shipping pallets, most commonly wooden but can be made of metal or plastic, arrive at the airport from deliveries of goods from vendors serving both the airport and airport tenants. Contractual arrangement with vendors to allow return and reuse of the pallets with new shipments should be identified and promoted.

Due to the numerous deliveries at any airport, cardboard has become a typical recycled item. Bailers and bins are placed in locations around terminal loading docks and in facilities yards to deal with this voluminous waste stream. Bailed, cardboard boxes have a relatively high resell market value and often are the “low hanging fruit” in an airport’s recycling scheme.

General MSW Case Studies:

- **Denver International Airport (DIA)**
- **John Wayne Airport (SNA)**
- **Minneapolis Airport**
- **Oakland International Airport (OAK)**
- **San Francisco International Airport (SFO)**
- **Yeager Airport (CRW)**

ii. Green Waste

Green Waste Case Study:
San Diego International Airport (SAN)

Depending on the local climate and physical environment, there are various options available at airports to reduce the amount of green waste generated, which include the following best management practices:

Landscape Design and Plant Selection. A well-planned landscape design can help prevent or reduce the amount green waste produced or and amount of resources expended for its maintenance. Each region of the country has different resource conditions, such as the amount of annual rainfall, soil type, temperature ranges and available sunlight, all of which need to be taken into consideration when planning landscape design and plant selection. Finding the right balance of plant types and efficient irrigation systems can provide both the optimal aesthetics and resource conservation goals of the airport.

- *Xeriscaping.* The practice of xeriscaping applies to landscaping that uses slow-growing, drought-tolerant plants, which conserve water and reduce the amount plant trimmings, and ultimately waste generation. In many instances, this involves the selection of indigenous, native plant species, which are already accustom to the regional climate and environment. In addition, xeriscaping generally requires far less fertilizer, herbicide and pesticide use than traditional landscaping methods and therefore is more environmentally sustainable.
- *Grasscycling.* The practice of grasscycling simply means leaving the grass clippings on the lawn after mowing. The grass clippings quickly decompose, allowing valuable nutrients and moisture to return back to the soil. Grasscycling saves time and money by reducing the mowing time (since bagging and discard of clippings is eliminated) and the amount of fertilizer, herbicides, pesticides and water needed to maintain a healthy turf. Consequently, it is also good for the environment by minimizing the amount of potential pollutant discharges going to the storm drain system and beyond.
- *Mulching.* The process of mulching involves physically breaking up the landscaping trimming using a chipper, grinder or other mechanical means. The resultant "mulch" can then be applied as a protective cover over bare areas of soil to retain moisture, provide insulation from cold weather, reduce erosion, provide nutrients, and suppress weed growth and seed germination. The mulching of landscaping waste can take place on site for direct application or it can be hauled off to a local mulching or composting facility for processing.

- *Alternative Daily Landfill Cover.* Another application of green waste is in its use as alternative daily cover at municipal solid waste landfills, where permitted. Using green waste as daily cover, in lieu of soil cover, saves valuable landfill space and may count towards waste diversion goals in many jurisdictions. Generally, the green waste is hauled directly to the landfill, where it is shredded, stored and applied as daily cover material.

iii. Deplaned Waste

Deplaned Waste Case Study
Portland International Airport (PDX)

On average, 20% of a commercial service airport's municipal solid waste is from deplaned waste.[3] Analysis has shown that 40% of this total could be readily recycled.[4] For example, by weight #1 PET plastic bottles represent about 1% of deplaned waste, and aluminum cans roughly 3%, with mixed paper being the largest fraction that is easily recyclable.[5] Other deplaned material destined for disposal includes things that could be handled through better management, such as large quantities of used travel kits, head phones, partial rolls of toilet paper, and clean, unused paper products. Food waste and soiled paper are easily compostable; however, easy access to composting facilities is not widespread across the U.S. yet.

There are a number of airline participants that would need to be involved in comprehensively addressing deplaned waste, including purchasing, inflight catering, flight attendant services, and cabin cleaning. There is great variability among airlines in their approach to recycling deplaned waste, and significant room for improvement. Airports can play an important role in working with their airline tenants in providing adequate facilities for recycling deplaned waste. There are numerous documented instances of source-separated recyclable material being thrown in the trash due to poor communication and inadequate facilities.

As mentioned in the introduction, there is a portion of deplaned waste known as international waste that has to be processed separately. However, even some of these wastes could be recycled. The best opportunities for recycling international waste are with cans, bottles, newspaper/magazines that have not come into contact with food, or plastic containers that haven't held milk or dairy products and have been stored separately from the other international waste. These items can be included in an airport's recycling stream without being incinerated, sterilized, or ground up. Bins are often provided for by an airport where recyclable materials can be collected, or the recyclables are rounded up for redemption by the airlines at their designated station.

Airline purchasing departments should carefully choose the products that go on board to make waste management easier. Rather than a disposable travel kit on every seat for international flights, for example, providing those kits on request would reduce waste. Some airlines already have locations where discarded newspapers and magazines can be used by other passengers; this type of reuse should be encouraged.

[3] Airports such as PDX have reported up to 40% of the airport's waste as deplaned waste (PDX, June 2011)
[4] *Id.*
[5] Based on PDX audits conducted in January and June 2008.

One of the challenges to reducing deplaned waste by recycling materials is that there is not a national program established for all airports to process deplaned waste the same way. Due to the complexity and variability of recycling and waste collection in the United States, it is challenging to implement a "one size fits all" approach to recycling for airports and airlines. The materials mix that Materials Recovery Facilities will accept varies substantially not only nationally and regionally, but often within a single community, making a streamlined collection process a major challenge. Increasing landfill diversion rates from deplaned waste collection will remain difficult until standards of collection and regulation are adopted.

If there was a national standard airlines that serve multiple markets would be able to establish uniform procedures knowing that facilities will be available to manage their deplaned recyclables. In addition, airports would be able to increase their overall recycling rates knowing that there will be consistency in how material will be coming off planes. If there was a national standard, materials could be comingled in collection bags, and easily separated at a sorting facility. On board collection could consist of two bags, one for these recyclable materials, and one for everything else. It is recommended that clear plastic bags be used for both the recoverable material and that to be disposed, so that materials can be easily identified. The clear two bag system could be used by both flight attendants and cleaning crews.

6. Education and Outreach

Initial communication before implementation of the program, continuing education, and ongoing facilitation with each of these groups and awareness of the different role each plays in the airport program will be pivotal for success. Many airport tenants, contractors (such as janitorial service companies) and concessionaires have significant employee turnover. Therefore, recurring training is required to ensure that the airport staff is well versed in the program specifics. In addition, some of the staff may not use English as a primary language, therefore the training materials and signage should be addressed appropriately.

Training Case Studies:

- **Denver International Airport (DIA)**
- **Oakland International Airport (OAK)**
- **San Francisco International Airport (SFO)**

Whenever possible, it is helpful to share with the public and stakeholders data and metrics about the positive impact that the program is having on the environment. Waste reduction decreases transportation emissions and saves energy by using fewer resources. Producing new products from recovered materials lessens the need for mining or harvesting virgin materials. The EPA's Waste Reduction Model (WARM) allows organizations to estimate the greenhouse gas and energy savings from recycling, composting and source reduction.

7. Monitor and Refine

Throughout the implementation of the recycling program, there should be continuous monitoring and refinements to the recycling program to ensure that recycling is encouraged.

8. Performance Monitoring

Ideally, specific program goals should be set prior to initiating collection. In many cases, targets will be created in part by local government and state mandates. For example, certain jurisdictions may require the airport to recycle a certain percentage of its waste to help achieve this particular goal. In other cases, targets will be primarily internal. There is increasing pressure to increase waste diversion rates in many regions of the country, and some areas are setting mandatory minimums. These local or state goals can be starting points for many programs. Conversely, there may be little political or economic incentive in a region, but an operation with the size and impact of an airport may help push and develop markets for recycled commodities to create momentum in the regional marketplace.

The performance monitoring measures will help to communicate the successes of the recycling initiative at the airport. Quantifying how much waste is being recycled and compare this to baseline waste audit information can be helpful to show management and the public how the program is helping to reduce waste.

9. Promote Success

Promoting the success of the recycling program will ensure that the public, tenants, and management continue to support the initiative.

10. Continuous Improvements

The airport recycling coordinator should evaluate the program over time and consider new initiatives to help reduce waste and promote recycling or reusing materials.

B. Challenges for Setting up a Recycling and Waste Reduction Plans at Airports

Implementing and maintaining a successful recycling/waste minimization program at any organization can be challenging. Given the size, complexity, and pace of an airport environment, these challenges are greatly exacerbated. There are a number of common obstacles that impede the development and ongoing progress of a successful program.

- *Dealing with multiple entities:* There are multiple stakeholder groups that impact and are affected by recycling and waste collection in an airport environment. This creates a complex system with many opportunities for unintended consequences. Therefore, an appropriate recycling strategy should consider all groups that participate, and how they interact with one another, in order to create an optimal strategy for the success of the program.
- *Fractured/disjointed management chain:* Due to high employee turnover among concessions and tenant staff, it is difficult to get consistent compliance and proper waste sorting and disposal. Constant feedback, education, and ongoing technical assistance are pivotal for success.
- *Incentives structure:* In areas where the airport authorities are responsible for tenant and airline waste management, incentives structures that encourage waste minimization must be considered. Additionally, in regions where landfill disposal fees are low, strategies need to be developed to encourage waste minimization.

- *Space needs:* To make proper waste minimization and collection a priority, convenient and ample space must be provided at the terminal. With cost and space as pivotal factors, waste collection is often an afterthought, forcing less-than-ideal conditions for collection and the need for improvisation.
- *Airfield security:* Security measures complicate access for the waste hauler to airport areas such as ramps and loading docks.
- *Maintenance:* Maintaining an appropriate number of staff to keep waste areas clean and free from discarded materials is critical. If left unchecked, waste areas will quickly become a "dumping ground" for materials and wastes beyond the scope of the program.
- *Language or cultural barriers:* Multiple languages and cultures can present communication challenges, especially in the development stages of a program or a particular initiative. It is especially important to be sensitive to cultural and language issues as plans are established and the waste recycling system is implemented.
- *Human nature:* A successful waste collection area must be designed with human psychology in mind. Simple paths towards different waste collection are important, and collection containers should feature clear, consistent language and presentation.
- *Lease language:* Lack of specific recommendations for materials procurement, employee training, guidelines, expectations and recommendation for airport tenant compliance with waste program protocols can provide significant challenges to successfully executing an airport waste program.

III. CONSTRUCTION AND DEMOLITION WASTE (CWM) PROGRAM

This section discusses the reuse and recycling of construction materials, including benefits, costs, goal setting, types of construction and demolition (C&D) debris, CWM Plans, best practices, implementation considerations, tracking and reporting, markets for recycled materials, lessons learned, and resources.

A. Objectives of a CWM Program

A CWM program is dependent upon development of goals, sustainability guidance, and use of more specific implementing mechanisms through use of standards, specifications, project tracking checklists, and standardized reporting formats.

Two Primary Objectives of a CWM Program

1) **Divert construction and demolition debris from disposal in landfills and incineration facilities; and**
2) **Redirect recyclable resources back to the manufacturing process and reusable materials to appropriate sites.**

C&D debris can be defined as the non-hazardous solid waste stream than results from land clearing, excavation, and/or the construction, demolition, renovation, and repair of structures, roads, and utilities. C&D debris commonly includes concrete, asphalt, wood, metals, drywall, carpet, plastic, pipe, rocks, earthwork, land-clearing debris, cardboard, and salvaged building components. C&D debris makes up roughly 25 percent of all solid waste discarded in the U.S.[6]

Some airports have developed CWM programs to encourage recycling and reuse of non-hazardous wastes and materials generated during construction, demolition, renovation, maintenance, and repairs.

An efficient construction waste program may provide the following benefits:

- Economic – Provides cost savings from reduced material hauling, disposal fees, and fuel costs, and avoiding purchasing new materials. Job site recycling creates employment and economic activity that benefits local economies.
- Environmental – Reduces the amount of materials sent to landfills and the environmental impacts of extracting or producing new materials. The reuse of materials on-site reduces off-site hauling, and decreases transportation air emissions and fuel burn.
- Operational – Streamlines the quantification and organization of materials on-site, reducing impacts to airport operations. Less time and labor may be needed for hauling, installation and maintenance.
- Social – Reduces traffic in the surrounding community through reduced off-site hauling.

[6] Lennon, Mark, The Institution Recycling Network, *Guide to Construction and Demolition Recycling*, page 2, April 2005, www.mass.gov/dep/recycle/reduce/cdrguide.pdf (accessed May 14, 2012).

B. Involving Contractors and Other Stakeholders

Procurement Case Studies:

- **Chicago O'Hare International Airport (ORD)**
- **San Francisco International Airport (SFO)**
- **Salt Lake City International Airport (SLC))**

A successful CWM program means starting early; incorporate a CWM program from the start to guarantee success. Include recycling requirements in all contracts, subcontracts, and purchase orders. All applicable goals, guidance, and required standards and specifications to be applied need to be addressed prior to contracting and acknowledged during the procurement stage. This includes addressing CWM requirements during pre-proposal or submittal conferences, providing requirements in advance, in RFQs/RFPs, and other materials. Confirmation of any applicable "green building standards" or airport sustainability guidance manuals should be clearly made. Pre-bid meetings to clarify expectations, requirements, and performance criteria are also a valuable tool for the airport and contractor to emphasize managing resources in economically and environmentally responsible ways (e.g., waste reduction, reuse and recycling).

Be upfront to ensure contracts highlight repurposing, reusing materials/salvaging, and how use of recycling materials is defined. Contracts should establish clear minimums (goals) and applicable standards and specifications. Contracts can require preparation of a CWM Plan, establishment of a CWM coordinator/manager, and tracking and reporting requirements. Resource Management contracts, which typically include pre-bid meetings to clarify expectations, requirements, performance criteria, etc., can also be a valuable tool for the airport/contractor to emphasize and/or reward managing resources in economically and environmentally responsible ways (e.g., prevention, reuse, and recycling).

Continual training helps ensure understanding and compliance with established goals and requirements. Conduct periodic training workshops to explain goals, requirements, and tracking and reporting requirements. Reward and recognize contractors and employees for meeting and exceeding goals and related achievements. A variety of incentive programs can be considered to monetize complying with and exceeding established CWM recycling goals. The incentives can be monetized to financially reward contractors through reduced costs, incentive payments, or bonuses. Non-financial incentives include award and recognition programs that recognize savings, achievement of goals, and overall performance.

C. Establish Construction and Demolition Diversion Goals

To achieve the economic, environmental, operational, and social benefits of implementing a CWM program, establish upfront minimum goals for recycling and reusing and/or salvaging non-hazardous C&D debris. To facilitate this process, the airport/contractor should adopt a CWM Plan to maximize the diversion of materials from disposal and expedite recycling and reuse of materials in projects.

Goals can be established formally through environmental or sustainability management plans and other sustainability related programs, implementation of standards and specifications, and contractual requirements, perhaps in parallel with other state or local requirements. Goals can also be achieved indirectly through cost-savings considerations. For example, re-use of materials can lower acquisition and disposal costs, and environmental initiatives can reduce fuel usage and

air emissions. Today, airports such as San Diego and Chicago are achieving a high percentage of material recycling and recovery, approximating a 98% recovery rate.

Diversion should include the salvage of materials on-site or the donation of materials to charitable organizations.[7] Each airport and/or contractor should determine the market for recycling or reusing materials in its area, and the available haulers and recyclers to handle the materials. The particular location and project could influence the airport's diversion rate goal. For example, relocating airfield security fencing may have a higher diversion rate goal compared to construction of a taxiway.

D. Developing a Construction Waste Management (CWM) Plan

Implementation of a CWM program is a start-to-finish process, beginning long before project start with development of goals, standards and specifications to implement those goals, reflection during the procurement process and contracting, training, and incentives through cost savings, awards and recognitions. A CWM program is dependent upon development of 'Sustainability Design and Construction' guidance, along with implementing mechanisms through use of standards and specifications and project tracking checklists.

At a minimum, a CWM Plan should identify the anticipated types and quantities of materials to be diverted from disposal and the required process for on-site and off-site sorting or comingling of materials.

CWM Program should consider the following construction and demolition debris for recycling or reuse:

- **Earth, Soil, Dirt**
- **Concrete Reclaimed Asphalt Pavement**
- **Bricks/Masonry (cinder blocks, mortar, etc.)**
- **Rock, Stone, Gravel**
- **Ferrous Metal (iron, steel, etc.)**
- **Nonferrous Metal (aluminum, copper, etc.)**
- **Roofing Shingles and other Roof Materials**
- **Cardboard, Paper, Packaging**
- **Sand**
- **Wood**
- **Gypsum Drywall**
- **Plastics**
- **Plaster**
- **Paint**
- **Plumbing Fixtures and Piping**
- **Carpet and Pad**
- **Non-Asbestos Insulation**
- **Glass**
- **Land-Clearing Debris**

Included within the CWM Plan is consideration of a "balanced earthwork management plan" that outlines procedures and best practices to maintain and utilize excavated soil and land-clearing debris on-site and/or for other nearby projects. As such, the airport and contractor(s) need to

[7] U.S. Green Building Council, "MR [Materials and Resources] Credit 2: Construction Waste Management," LEED® 2009 Reference Guide for New Construction and Major Renovations," updated October 2010.

evaluate cut-and-fill needs early on to maximize the potential benefits of matching available soil and material resources with project needs.

A CWM Plan typically consists of the following information:[8]

1. **General**: An overall strategy for managing the project's C&D debris. Describe the general intent of the project with regard to the diversion of C&D waste from the landfill or incinerator and the recovery of materials where applicable.

2. **Regulatory**: Reference all applicable laws, municipal codes, regional plans, city or airport sustainability manuals, construction specifications, and any other appropriate standards and specifications. The contractor must comply with waste transport, disposal, stormwater, and other regulations of state, local, and/or federal authorities having jurisdiction. The CWM Plan should clearly indicate that the contractor is responsible for providing waste handling, containers, storage areas, signage, transportation, and other items to facilitate implementation of the CWM Plan for the duration of the contract.

3. **Waste Identification:** The anticipated types and quantities by weight of demolition, site-clearing, and construction waste generated by the project, including the assumptions for the estimates. Calculations should be done by weight (conversion may be necessary) and must be consistent throughout. The CWM Plan should include:
    - Completing a 'Materials Handling Estimate Worksheet' for all applicable project waste streams.
    - Identifying where recyclable materials storage and collection points will be.
    - Identifying a plan to communicate recycling goals with employees and subcontractors.

4. **Waste Reduction Work Plan**: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total weight of each type of waste, final disposition for each waste type, and handling and transportation procedures.

    a. *Salvaged Materials* – For each type of material that is salvaged or recycled, describe the type of material, source, estimated quantity, and receiving entity. Include names, addresses, and telephone numbers for the receiving individuals and/or organizations.

    b. *Disposed Materials* – Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

    c. *Handling and Transportation Procedures* – Describe the method for separating recyclable waste, including sizes of containers, container labeling, and the designated location where material separation will occur. CWM operations should be conducted in a manner to minimally impact airport and public roadways, streets, sidewalks, and adjacent facilities. A site should be designated for the classification of materials to be salvaged,

[8] Chicago Department of Aviation, *Sustainable Airport Manual*, Version 2.1, Section 5.0 Materials & Resources, 5.3 Construction Waste Management, October 31, 2011.

recycled, reused, sold, donated, or disposed. Waste materials should not be allowed to accumulate on-site. The C&D debris should be removed and transported in a manner that prevents spillage and all truck beds should be covered at all times during transport en route to the ultimate destination.

The airport and/or contractor(s) should continually track and report on quantities and types of materials generated, reused, and disposed of off-site, on compliance with sustainability goals and objectives, and on application of best practices to evaluate compliance with the CWM Plan and recognize completion of best practices. Metrics may include developing "Sustainability Design and Construction" guidance, along with more specific implementing mechanisms through use of standards and specifications, project tracking checklists and standardized reporting forms. Results can be reported in quantities achieved, resulting benefits, subsequent uses of materials, and results relative to goals. Additionally, programs and/or contractors can be further recognized by applying a rating and ranking program and an award recognition program.

Other Considerations

Depending on the number and size of projects, the airport may consider developing a sustainability design and construction review team comprised of project planners, construction management, and contractors to facilitate project reviews, reporting and tracking. Project reporting can be achieved through standardized checklists and forms that are submitted electronically. Holding training workshops for contractors can be a valuable tool for reviewing CWM tracking and reporting requirements.

The airport/contractors should further reduce the use of finite raw materials and long-cycle renewable materials by replacing them with high-recycled content, rapidly renewable materials and Forest Stewardship Council (FSC) certified wood products. Goals and percent requirements should be clearly established and communicated, and projects that include high-recycled content materials should be recognized and rewarded. "Closing the loop" by purchasing products made with materials recovered from recycling creates a market for materials recovered/recycled from projects. Programs can establish minimums, or higher content ratios to further facilitate 'buying recycled.' Typical construction related products with high-recycled content include:

- Steel Rebar (default 25% recycled content)
- Copper wire (assumed to contain 65% recycled content by default)
- Other metals
- Wood based products (pallets, forms, etc.)
- Carpet
- Windows, doors, framing
- Plastic products
- Building materials

5. Tracking, Reporting, Invoicing – CWM Submittals: Submit documentation demonstrating how the CWM Plan goals were met, which may include the following:

- Provide a design estimate of materials anticipated to be used, recycled, salvaged, and/or disposed of using the CWM form.
- Develop a full CWM Plan prior to start of construction, which includes a pre-construction estimate of construction material types and quantities to be recycled and/or disposed of during the project.
- Submit monthly CWM forms provided by the Contractor during construction.
- Complete material Handling Worksheets, which may include recycling receipts and weight tickets for all materials provided by the recycling facility to the airport/project manager.
- Provide a final construction waste total provided by the contractor prior to final payment.

Consider also assigning a CWM coordinator to be a single point of contact responsible for implementation, monitoring, and reporting of CWM activities. The contractor should be held responsible for training workers, subcontractors, and suppliers on proper CWM procedures. The CWM Plan must be distributed to all subcontractors and suppliers when contract work begins.[9]

Construction and Waste Case Studies

- **Chicago O'Hare International Airport (ORD)**
- **Denver International Airport (DIA)**
- **John F. Kennedy International Airport (JFK)**
- **Phoenix International Airport (PHX)**
- **Oakland International Airport (OAK)**
- **Salt Lake City International Airport (SLC)**
- **San Diego International Airport (SAN)**
- **Yeager Airport (CRW)**

[9] Chicago Department of Aviation, Specification 01524-9, *Construction Waste Management*, O'Hare Modernization Program Master Specifications, Revision 5, Issued July 30, 2010.

IV. CASE STUDIES, LESSONS LEARNED, CHALLENGES AND BEST PRACTICES

Case studies provide the opportunity to learn first-hand through an airport's existing program or experience. The case studies included in this Appendix present a sample of the various types of waste recycling, reuse, and reduction programs already in place at many airports. Many have seen substantial success and even cost savings in their implementation. Some have been in place for a number of years; some are just getting underway. These initiatives are happening at airports of all sizes and types, although the scale of their implementation may differ. For each case study presented, you are encouraged to view additional materials available on the case study airports website, or by contacting one of our committee members for more information.

This appendix includes 27 representative case study examples created through our Committee members and as an outgrowth of an industry-wide call for case studies facilitated by our industry partners including the American Association for Airport Executives (AAAE); Airports Council International-North America (ACI-NA); and the Airports Consultants Council (ACC).

A. Boston Logan International Airport (BOS), Boston, Massachusetts

Warm Mix Asphalt on Runway 4R/22L

Aggregate Industries Northeast Region recently placed 25,952 tons of warm mix asphalt on Runway 4R/22L at Boston's Logan International Airport, the first airport in the nation to use the environmentally friendly asphalt on a runway repaving project,. The priority was to reduce greenhouse emissions and energy during construction. According to BOS, warm mix uses 20 percent less energy to make, produces 20 percent fewer greenhouse emissions when applied, and allows a higher percentage of recycled asphalt pavement in the final product.

For more information on BOS' waste management programs, visit www.massport.com/environment/environmental_reporting/Pages/EnvironmentalReporting.asp

Contact: Stewart Dalzell, Deputy Director Environmental & Planning Dept., Boston Logan International Airport, SDalzell@massport.com

B. Chicago O'Hare International Airport (ORD), Chicago, Illinois

Construction Waste Management Program

Chicago is completing the multi-phased O'Hare Modernization Program (OMP) that includes the construction and commissioning of four new runways and the extension of two others at ORD. Due to the large nature of the OMP, opportunities exist for on-site material recycling, especially for the aggregate and paving materials.

Construction waste generated as part of the OMP is used on other OMP-related projects or hauled to nearby debris sorting facilities to maximize the recovery of materials. Over 600,000 tons of materials have been recycled, including concrete and asphalt, bricks, scrap metal, light

bulbs, and landscaping waste. Over 98% of OMP C&D debris has been recycled and prevented from entering area landfills.

Through March 2012, the OMP has managed approximately 20 million cubic yards of soil on-site, saving more than $140 million either by incorporating it as part of new projects or stockpiling it for future use. As highlighted in the following table, the OMP's balanced earthwork plan, material recycling and reuse, have helped the Chicago Department of Aviation (CDA) achieve the triple bottom line.

Benefits OMP Balanced Earthwork Management Plan through March 2012

Quantities To Date (Through March 2012)	Description
Over 20 million	Cubic Yards of Soil Moved (enough to fill the Willis Tower 10 times)
Over 7 million	Cubic Yards of Excess Soil Kept On-site
Over 630,000	Haul Trips Saved
Over 1.1 million	Hours of Roadway Travel Saved
Over 47 million	Vehicle Miles Traveled (VMT) Saved
Over 7.2 million	Gallons of Diesel Fuel Saved
Over $140 million	Dollars Saved
Approximately 73,000	Tons of CO2 Saved

Source: Chicago Department of Aviation

1. *O'Hare International Airport: Guiding Construction Waste Management with the Sustainable Airport Manual And Detailed Specifications*

Focused Case Study

To ensure that sustainable initiatives were implemented during the build-out and modernization of ORD, the CDA introduced the Sustainable Design Manual (SDM) in 2003 at the start of the OMP, which was subsequently expanded into the Sustainable Airport Manual (SAM). The SDM/SAM positioned Chicago as the first in the nation to develop sustainable guidelines for design and construction at airports, establishing the model for green airport development. The SAM includes a project rating and certification system, and recognizes designers and contractors for sustainability accomplishments. The SAM has evolved to now encompass airport planning, design, construction, operations and maintenance, and concessions and tenants.

The Design/Construction chapter of SAM continues to guide the incorporation of sustainability into design and construction of civil-airside, civil-landside, occupied buildings, and unoccupied buildings/structures in an airport environment. Over 60 projects at Chicago's airports (O'Hare and Midway International Airports) have been reviewed by the SAM Green Airplane Rating System. As part of SAM, the CDA also developed a number of implementing specifications, including Specification 01524 Construction Waste Management which requires contractors to submit a CWM Plan, design estimate, monthly CWM forms, and a final construction total. For more

information, refer to the CDA's Sustainable Airport Manual, Version 2.1 (www.airportsgoinggreen.org).

For more information on ORD's programs, download the CDA's 2011 Sustainability Report at http://ohare.com/Environment/sustainabilityreport.aspx.

Contact: Chicago Department of Aviation, Amy Malick, Deputy Commissioner Sustainability, amy.malick@cityofchicago.org

C. Denver International Airport (DEN), Denver, Colorado

Waste Recycling and Waste Management Program

DEN continues to expand existing programs and explore new initiatives toward reaching the airport's strategic plan goal of becoming a zero-waste facility by 2020. In 2001, 0.64 pounds of waste per passenger was sent to the landfill. DEN has reduced this to 0.42 pounds per passenger in 2011 with a diversion rate of 12.5 percent. In 2011, DEN collected 1,571 tons of recyclable material (removing it from the municipal solid waste stream), including 59.7 tons of wood pallets, 767 tons of cardboard, and 75 tons of organic material. In addition, DEN recycled the following commodities, primarily from airport maintenance activities: more than 1,300 batteries; 26,012 pounds of electronics; 21,000 fluorescent lamps; 293 tons of scrap metal; 84,718 tons of concrete to recycle staging areas and 21,512 tons recycled in place; 11,549 tons of asphalt to recycle staging areas; 101,173 pounds of restaurant yellow grease; 1,750 gallons of antifreeze; 1,093 tires; 21,912 gallons of used oil; and 466 gallons of solvent.

Two additional programs DEN is pursuing include:

Composting – With the support of food concessionaires and janitorial staff who collect used paper towels from office restrooms, in 2011 DEN diverted more than 5 tons of organic material per month from the landfill. It is hauled to a commercial composting facility operated by A-1 Organics, where it is transformed into high-grade compost for residential and agricultural purposes.

Plastics Bailer – In May 2011, DEN was awarded an RREO (Recycling Resources Economic Opportunity) grant from the State of Colorado to purchase a plastic-film bailer. According to waste composition studies, between 80 and 100 tons of plastic film/wrap are thrown away each year by DEN and its tenants. DEN began using the bailer in January 2012 and expects to substantially reduce the amount of the plastic wrapping material going to the landfill.

1. *Denver International Airport; Pena Boulevard Construction Waste Management*

Focused Case Study

The DEN project team implemented a program that crushed, recycled, and reused roadway concrete in place along a stretch of Peña Boulevard reconstruction. This process saved the time, expense, and environmental impact of transporting old pavement and new base materials. This process saved 1,250 gallons of diesel fuel and avoided 1.5 tons of CO2 emissions and, most importantly, paved the way for broader applications of sustainable roadway improvement projects at DEN.

2. *Denver International Airport; Conducting A Waste Assessment (Waste Audit)*

Focused Case Study

In its 2009 Strategic Plan, Denver International Airport (DEN) set a goal for itself of becoming a Zero Waste facility by 2020. In 2010, DEN – utilizing Waste Management Inc.'s "Green Squad" - conducted a waste audit to analyze DEN's current waste streams, to identify how far DEN is from reaching 100% landfill diversion today, and to provide recommendations and solutions that will enable DEN to move closer to its Zero Waste goal. DEN conducted an assessment of waste generated from the following areas: Airport Office Building (AOB)/Main Terminal; Concourses A, B and C; East & West Overflow Parking; Air Cargo; Maintenance. The audit sampled 20 loads (totaling 5,395.5 lbs.) sorted into 31 material types. Weights obtained from the sorts were used to evaluate the effectiveness of DEN's current recycling programs, identify areas for improving both the current and future recycling programs, and for identifying potential savings opportunities associated with waste diversion strategies. Based on sample results, the assessment illustrated that DEN had an opportunity to decrease the amount of waste sent to landfill by over 62%, and, under current market conditions, the opportunity to save over $200,000 annually through avoided disposal costs and recycling rebate revenues.

The audit identified that up to 3,229.5 tons of recyclables (29.8% of the solid waste stream) on annual basis were sent to landfill instead of being diverted to the existing single-stream recycling program; as well as 24.1 tons (.2%) of recyclable e-waste; and 95.5 tons (.9%) of construction & demolition (C&D) materials. In addition, the audit suggested that DEN has the potential to divert up to 3,136.7 tons (28.9%) of its organics by expanding its current composting program to include pre-consumer and post-consumer waste throughout the entire airport. Finally, DEN could potentially divert an additional 170.9 tons (2.4%) annually by implementing new diversion programs. Resulting recommendations included: Improve educational awareness about DEN's zero waste goal and waste diversion throughout the entire airport; improve collection strategies to encourage more diversion; expand the current composting program to include pre and post-consumer organic material throughout the entire airport; and, implement new programs to divert additional materials.

For more information on DIA's waste management programs, see DIA's 2011 Annual Report, Managing the Environment and visit www.business.flydenver.com/environmental.

Contact: Aimee Fenlon, Environmental Public Health Program Administrator, City and County of Denver, Department of Aviation, Aimee.Fenlon@flydenver.com; or

Jerry Williams, Jerry.Williams@flydenver.com

D. Hartsfield-Jackson Atlanta International Airport (ATL), Atlanta, Georgia

Construction Waste Management Conveyor and Recycling

Hartsfield-Jackson International Airport in Atlanta is probably one of the larger airfield pavement recyclers, and has developed innovative programs to handle and process demolition waste for reuse in airport construction projects. ATL projects have incorporated in excess of 675,000 tons of recycled Portland cement concrete in projects involving reconstruction of Runways 9R-27L, Runway 8R-26L, as well as Taxiways "M" and "E." Additionally, the Airport utilized an overland belt conveyor system that transported 93 percent of the 21.5 million cubic yards of fill necessary for a new runway's construction, resulting in reduced truck trips, emission elimination, and diversion of construction material waste from landfills.

For more information on ATL's waste management programs, visit: www.atlanta-airport.com/airport/Environmental/MaterialsRecovery.aspx

Contact: Michael Chenye, Hartsfield-Jackson Atlanta International Airport, Michael.Cheyne@atlanta-airport.com

E. John F. Kennedy International Airport (JFK), Port Authority of New York and New Jersey (PANYNJ)

Construction Debris Recycling

Since January 2009, all PANYNJ contracts require the construction contractor to submit a Construction Debris Recycling Plan. The plan requires the contractor to provide documentation that 75 percent (by weight) of all steel, asphalt, concrete, and clean soil is recycled on a project-by-project basis. This goal has been met since the contract specification was introduced.

Example Project: Taxiway reconstruction/onsite material recycling. In preparation for the arrival of the A380 airplane, the centerline of one of the main taxiways at JFK needed to be shifted 16 feet for a total length of approximately 4 miles. A detailed study was conducted to evaluate the potential reuse of existing asphalt, lime cement fly ash pavements, and sandy subgrade soil. It was determined that the existing pavements could be reused onsite as a base

course for the new pavement. The pavement was removed, crushed, treated with Portland cement, and remixed onsite. A rigorous testing program was followed to ensure all specification requirements were met. This eliminated the need for approximately 25,000 cubic yards of virgin material, saved approximately $2 million in construction costs, and reduced truck traffic for aggregate delivery.

For more information on JFK's programs, see www.panynj.gov/about/airport-initiatives.html

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F. John Wayne Airport (JWA), Orange County, California

Recycling Programs

JWA is owned and operated by County of Orange, California. JWA began source-separated recycling in December 2008 at the Eddie Martin building and at the loading dock below the Terminal. Recycling carts and a 3 yard recycling bin were placed in the Eddie Martin building and a 40 yard recycling dumpster was placed in the loading dock. To facilitate use of the new recycling bins, JWA developed a pictorial recycling flyer so staff would know what goes where. Larger versions of the flyer were posted at each recycling bin. Bottle and can recycling was initiated with one major terminal vendor. Coffee ground collection and composting was initiated in 2010. JWA expanded its recycling to the public areas of the terminal after a terminal expansion project was completed in late 2011.

In 2009, the recycling rate for materials collected was 54%, a 12% increase over 2008. C&D tonnage from the terminal expansion project was recycled by private contractors. The total 2009 diversion rate including C&D was 85%, which increased to 87% in 2010. The recycling rate for materials collected also increased to 55%, a 1% increase over 2009. JWA continues to be committed to reducing its environmental footprint in an efficient, cost-conscious manner.

1. *John Wayne Airport - Coffee Ground Composting Program*

Focused Composting Case Study

In 2010, JWA initiated coffee grounds collection in partnership with its franchised waste hauler, Rainbow Environmental Services (Rainbow). Vendors selling coffee place their used coffee grounds in a separate recycling bin provided by Rainbow. Rainbow collects the grounds and transports them back to their facility in Huntington Beach where the grounds are proportionately mixed with processed green material. Once mixed in with the green material, the coffee grounds are transported to a certified composting facility where they are processed into compost. Since the inception of the program in 2010, JWA has diverted over 150 tons of coffee grounds, converting a former source of waste into a valuable resource.

For more information on JWA's program, see www.ocair.com/communityrelations/environmental.aspx.

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G. Los Angeles International Airport (LAX)/Los Angeles World Airports (LAWA), Los Angeles, California

Waste Characterization, Recycling and Waste Management Program

LAX has conducted several waste characterization studies and concluded that each passenger generates 0.9 pounds of trash and each air cargo ton handled at LAX generates 4 pounds of trash. Using this method, LAX's total waste generation in 2009 was 30,590 tons. In 2009, LAWA recycled 19,670 tons and diverted 631 tons to other uses, for an overall diversion rate of 66.4%.

In order to divert recyclable items from the waste stream, LAWA implemented a wide array of free recycling programs for its tenants and LAWA employees, some of the materials accepted in LAX's recycling program are cardboard, wood pallets, plastic, beverage containers, mixed paper, and metals. Construction and demolition materials, including carpet, green waste, mixed batteries, and other e-waste is recycled through LAWA's own in-house program. Grass clippings and tree branches are sent to the city's joint processing center to be composted.

LAWA asks that tenants report any recycling done outside the program. Below is a sample of select materials recycled in 2009 by tenants and LAWA at LAX.

RECYCLED MATERIAL	TONS
Mixed Paper	5581
Glass	18
Metals	440
Mixed Green Waste	341
Wood Panellets	1146

LAWA also designates materials for reuse or donation. Wooden pallets, cardboard, office paper, and scrap metal are reused if at all possible. Donations of packaged and prepared food from airline caterers are sent to local food banks in order to support the local community and avoid excess waste.

Some new projects are being developed at LAX include the following:

- Installing new advertising "amenity units" incorporating recycling collection into the advertising concession program. These units provide several openings for mixed paper/newspaper, cans, plastics and trash.
- LAWA plans to begin recycling coffee grounds and filters into compost from the multiple tenants and office spaces that dispose of coffee wastes on a daily basis.

- A feasibility study is being explored to expand the current cooking oil and grease recycling to an airport-wide collection program. In 2005, 30,350 lbs. of oil and grease were recycled by tenants.
- LAWA is considering a mandatory recycling clause in all airport concession contracts. Currently the program is voluntary, although LAX provides incentives for tenants to participate.

1. Los Angeles International Airport: Recycled Content Plastic Trash Bags

Focused Case Study

A California recycling law passed in 1989 required all cities and municipalities to divert at least 50% of their waste stream from landfills by recycling, reuse, source reduction and composting by the year 2000. To meet this recycling goal, LAWA developed a comprehensive, facility-wide recycling program for all airport users. Source reduction is one element of the program that helps toward the recycling goal. With more than 60 million passengers traveling through its terminals each year, LAX purchased 218.2 tons of plastic trash liners (small, medium, and large sizes) in 2010. That's more than 430,000 pounds of trash bags alone, without even counting the weight of the trash! To reduce the airport's impact, LAX purchases trash bags that contain 10% to 20% post-consumer recycled polyethylene, helping to reduce landfill waste by 20 to 40 tons per year. LAX has reached a waste diversion rate of 67.2% and is on track for the 70% target by 2015.

For more information on this LAWA's sustainability programs, see www.lawa.org/welcome_LAWA.aspx?id=1916.

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H. Minneapolis-St. Paul International Airport (MSP), Minneapolis, Minnesota

Recycling and Composting Programs

The Metropolitan Airports Commission (MAC) is committed to reducing and recycling waste at Minneapolis-St. Paul International Airport (MSP). The MAC has identified the following reasons to support recycling: to conserve resources by reducing demand for raw materials; to reduce dependence on landfills; to avoid solid waste disposal costs ($47/ton); to avoid solid waste taxes and fees (31.5% locally); to reduce environmental liability; and to lead by example.

The MAC recycles: paper, cardboard, metal, glass and plastic bottles, batteries, food/organic waste, grease, wood pallets, tires, construction materials, tree/yard waste, paint, automotive oil, used oil filters, antifreeze, solvents, deicing fluid, light bulbs and printer cartridges. In addition,

used oil is re-refined, used absorbents are burned for energy recovery, and oil-based paint waste and gasoline and diesel fuel wastes are fuel blended for energy recovery.

In 2011 the MAC diverted and recycled: 70 tons of scrap metals; 171 tons of pallets; 245 tons of baled cardboard; and 637 tons of co-mingled recyclables. In addition, the MAC recycled 154 tons of regulated waste materials including: 91.1 tons of used cooking oil; 1.5 tons of parts cleaners and solvents; 15.2 tons of tires; 25 tons of used oil; 7.9 tons of fluorescent and HID lamps; 10 tons of batteries; 1.6 tons of light ballasts and transformers; 0.8 tons of antifreeze; and 1.4 tons of paint.

In 2011, 91.1 tons of used cooking oil/grease from terminal restaurants was recycled. The used cooking oil is processed offsite and converted into biodiesel.

In 2010, the MAC implemented a pilot program for back-of-house organic waste diversion in airport terminal restaurants. Through this program MSP concessionaires worked to keep 120 tons of food waste out of the solid waste stream in 2011. MAC Field Maintenance generates large volumes of yard waste (brush, grass, and tree trimmings) in the course of maintaining landscaped areas. In 2011, 6.64 tons of material was collected. Food waste and yard waste are sent to a local composting facility where, after a few months, it becomes a valuable soil amendment product. Finished compost is mixed with topsoil and used by landscape contractors and public works entities, and MAC Maintenance uses it for landscaping at MSP.

Year-round mechanical sweeping of hundreds of acres of pavement at MSP generates a mixed load of sand and debris. Classified as an industrial waste, this material is segregated based on composition and is run through a screener; the clean sand is able to be reused on site, eliminating hundreds of tons of material from landfill disposal.

For more information on MSP's sustainability and waste management programs, see www.mspairport.com/about-msp/sustainability.aspx

1. *Minneapolis-St. Paul International Airport, Hazardous Waste Management Recycling*

Focused Case Study

Hazardous wastes are defined as materials that "…pose a substantial, present or potential hazard to human health or the environment". Such wastes are typically associated with vehicle and equipment shops or facility maintenance, including painting. Hazardous waste generators are required to be licensed and pay fees based on the amount of waste generated and the management method for different wastes. Waste reduction efforts at MSP include process changes, equipment upgrades, employee training, product substitution and researching alternate disposal methodology. Reducing the amount of hazardous waste produced by MSP operations provides economic and environmental benefits. Benefits of waste reduction include: reduced disposal costs; reduced fees and taxes - based on waste volume; reduced administrative costs for training, paperwork; and reduced environmental liability. In 2011, MSP recycled 154 tons of additional materials

including: 91.1 tons used cooking oil; 1.5 tons parts cleaners and solvents; 15.2 tons tires; 25 tons used oil; 7.9 tons fluorescent and HID lamps; 10 tons batteries; 1.6 tons light ballasts and transformers; 0.8 tons antifreeze; and 1.4 tons paint. What hazardous-type wastes are generated and how are they managed?

- Used oil is re-refined
- Batteries are recycled
- Parts washing solvent is recycled and reused on site
- Antifreeze is recycled and reused on site
- Used absorbents are burned for energy recovery
- Used oil filters are recycled
- Fluorescent and HID lamps are recycled
- Ballasts and transformers are recycled
- Mercury containing items are recycled
- Water based pain waste is recycled into concrete
- Oil based pain waste is fuel blended for energy recovery
- Gas and diesel fuel wastes are fuel blended for energy recovery.

For more information on MSP's sustainability and waste management programs, see www.mspairport.com/about-msp/sustainability.aspx

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I. Oakland International Airport (OAK), Oakland, California

Waste Reduction and Recycling Programs

OAK's waste reduction and recycling program covers general aviation activities and office areas on the north field, as well as two commercial passenger terminals, concessionaires, airlines and office areas on the south field. Materials collected include food waste, newspaper, cardboard, magazines, office paper, plastic, glass, aluminum and other metals. In fiscal year 2011-2012, 152 tons of kitchen scraps were composted from OAK concessionaires and 496 tons of recyclable materials were prevented from entering area landfills – a diversion rate of 38%.

OAK works closely with its airline partners to match existing corporate recycling programs with on-the-ground recycling facilities. OAK staff conducts year-round training sessions with tenants, concessionaires and custodial staff to continually improve program successes. In 2008, OAK was the first airport in the country to install two chute rooms inside the passenger terminal to facilitate recycling. In January 2011, 3 liquid collection stations were installed at the head of security lanes to reduce the weight of the waste and recycling receptacles, leading to fewer staff injuries, savings of staff time and disposal cost-savings. A Big Belly solar trash/recycling compactor pilot project was completed last year and a new pilot project to compost paper towels from restroom areas is under development.

OAK hosted a special weeklong AOA (Airport Operations Area) Spring Cleaning Event in April 2012 to promote the OAK's commitment to cleanliness, airfield safety and foreign object debris (FOD) awareness while educating tenants on OAK's Recycling Program and commitment to sustainability. Participants included 11 commercial airlines, four air cargo operators, two ground-handlers, four concessionaires, 169 general aviation tenants, three full-service FBOs, the TSA, and the FAA. A total of 20.4 tons of material was collected, 17.6 tons of which (86%) were recycled.

OAK's award winning Materials Management Program (Program) recycles concrete, asphalt and soil from construction projects, resulting in less traffic, fewer emissions and less landfill waste. Since 2003, the Program has saved over $7.5 million in waste disposal costs and $1.3 million in material import costs. The Program has taken more than 425,000 tons of demolition materials, reclaimed 270,000 tons of reusable materials, saved 4,000 metric tons of greenhouse gases and removed 150,000 pounds of vehicle emissions from the air.

For more information on OAK's recycling programs, see www.oaklandairport.com/noise/environmental_recycle.shtml.

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J. Philadelphia International Airport (PHL), Philadelphia, Pennsylvania

Organic Waste Recycling Program

In 2011, PHL initiated an Organic Waste Pilot Program, partially funded by United States Environmental Protection Agency and launched by the Airport to determine the feasibility of implementing an airport-wide composting program. The Organics Pilot Program installed receptacles at participating restaurants to evaluate the practicality, productivity, and cost-effectiveness of a composting program at PHL. The results were encouraging: 6,041 pounds of waste were collected, which averages out to about 431.5 pounds per day. The compostable waste material was appropriately labeled and sent to the Wilmington Organics Recycling Center (WORC) in Wilmington, Delaware, to complete the composting process.

The Organics Pilot Program highlights the relative ease with which PHL employees responded to the training sessions and became acclimated to the addition of the receptacles. Based on reports from the staff, the relocation of this waste did not "interfere significantly with existing business practices." The Pilot program's success prompted PHL to consider expanding the program throughout the terminals. The implementation of this program, in combination with recycling programs already in place, ensures that 73% of restaurant waste is diverted from landfills.

For more information on PHL's programs, see www.phl.org/AboutPHL/Environmentalinitiatives.

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K. Phoenix Sky Harbor International Airport (PHX), Phoenix, Arizona

Construction Waste Management Program

Description: Taxiway C serves Runway 8-26, the longest and most heavily used runway at PHX. PHX's Taxiway C Infill Project added a 2,200-foot segment at the west end of Taxiway C. The design team was required to comply with the PHX Design and Construction Services Green Guide, a performance based standard with life cycle and life cycle cost analysis tools for addressing design and construction impacts where LEED® is not applicable, such as for pavements and non-building construction.

All components of the designed pavement materials and structural cross-sections were analyzed, including the existing unsuitable soils and asphalt pavement which had been planned for removal and disposal. It was determined that the underlying soils could be mixed with cement to provide a suitable soil-cement subgrade for the project and the existing asphalt paving could be milled and recycled as new base material, which saved $200,000.

Use of the design decision support tool "Pavement Life-Cycle Assessment Tool for Environmental and Economic Effects" (PaLATE), an Excel-based tool developed for the assessment of the environmental and economic effects of pavements, allowed a detailed study of 12 separate concrete mix designs with varying amounts of cement and fly ash to determine the most long-term cost effective, long-lasting, and environmentally friendly paving material.

Specific construction quantities for the project were loaded into the PaLATE program and an estimated use of environmental resources and air emissions for each design was produced. Travel distance factors were included so that a comparison of energy consumption between recycled pavement and subgrade hauled from off-site could be made. The comparison of the designs showed that significant savings in environmental resources could be identified.

Other sustainability project decisions were made using the PHX Design and Construction Green Guide such as:

- Developing a vehicle and construction equipment anti-idling plan
- Utilizing EPA-rated higher tier low-emission construction vehicles
- Evaluating and mitigating project energy use
- Maximizing on-site salvage and reuse of materials and resources
- Detailed construction scheduling and sequencing plan to reduce emissions, including use of a compressed workweek
- Prevention of roadway damage during construction and reducing construction traffic

The Taxiway C Infill project had a construction cost of $10.36 million and the Aviation Department estimates the innovative design resulted in a total cost savings of $1.36 million.

For more information on this PHX program: Phoenix Sky Harbor International Airport and Huitt-Zoliars, "'Green' is the New White for Concrete Pavements – Phoenix Sky Harbor International Airport," http://skyharbor.com/community/environmentalPrograms.html.

1. *Phoenix International Airport Runway Friction Rubber Removal Recycling*

Focused Case Study

Like many airports, PHX uses a heated high pressure water blasting method for friction improvement on runways and other aircraft movement areas. The vacuumed waste is run through a set of filters within the truck to reuse the water, but at completion of the process, there is a water and rubber mixture from emptying the truck filters.

In the PHX Facilities yard, a Baker Tank has been plumbed to the sanitary sewer where this waste can be decanted. The water portion of the mix is permitted to be discharged to the sanitary sewer and the rubber solids from this process go to a local recycler for use in the development of rubberized asphalt. The City of Phoenix has used rubberized asphalt for roads since the early 1960's and rubber recycling is a mature local market.

These wastes go through analytical testing to screen that it is not hazardous waste (especially, metals) and for sewer discharge approval of the decanted wastewater. PHX's costs for this recycling process are approximately $300 per month, including analytical testing and handling.

For more information on this PHX program: Phoenix Sky Harbor International Airport and Huitt-Zoliars, "'Green' is the New White for Concrete Pavements – Phoenix Sky Harbor International Airport," http://skyharbor.com/community/environmentalPrograms.html.

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L. Portland International Airport (PDX), Portland, Oregon

24-Hour Waste Characterization Study

In 2010, a 24-hour waste characterization study was conducted at PDX. The purpose of this study was to gain a better understanding of the source areas where waste and recycling at PDX is being generated and to enable the PDX Waste Minimization Team to learn how best to target their efforts. The largest source area is airline waste (deplaned waste) which consists of waste generated onboard the aircraft. Public area waste is the second largest source area and consists of waste generated in the public areas of the PDX terminal. This includes waste from parking garages, pre and post security area, restrooms and food courts. Concessions waste is the third largest source area and it consists of all waste generated by concessions and retail tenants operating at PDX. This includes back of house waste as well as waste generated by customers in tenant controlled seating areas. The fourth largest source area is administrative waste. This consists of waste that is generated by the offices located at PDX and airline ticket counter waste.

The study provided detailed data on the recycling rates of each source area as well as individual tenants at PDX. For the study, the central collection area was monitored for a 24-hour period,

beginning at 12:00 midnight. Waste loads were intercepted before employees placed it into the designated receptacle.

Airline waste contributed approximately 44% of the materials collected. This is the largest contributing source area of the PDX waste stream. The airline waste recycling rate could be improved by:

- Keeping ice and liquid from the landfill bound waste load.
- Continue to provide specialized recycling support to individual airline tenants.
- Facilitate communication between airlines and their ground service provider to increase the rate of capture of materials accepted into the commingle recycling system.

Public area waste contributed approximately 35%, making it the second largest contributing source area. One of the most frequently observed materials found in public area landfill bound waste and commingled recycling are single use beverage cups; more than 6,000 cups of coffee are sold in the Port terminal each day. Currently, the PDX Waste Minimization Team is working with concessions tenants to explore the options for getting cups out of the landfill bound waste stream. The landfill bound waste stream could be decreased by:

- Expanding public area food composting.
- Encouraging concessions tenants to switch to durable or compostable serviceware instead of the current single use serviceware.
- Continue to work with coffee tenants, regional MRF's and paper mills to explore the options for recycling hot beverage cups
- Continue public education and outreach about the Port's recycling system.
- Explore other more sustainable options for reducing the quantity of paper towels by switching to durable towels or hand dryers in public area restrooms.

Concessions waste contributes approximately 18% of the PDX waste stream making it the third largest contributing source area. In many cases bags designated as trash contained predominantly food waste and other compostable materials. Recommendations for improved recycling among concessions tenants:

- Continue providing education about composting to decrease the amount of food waste present in the landfill bound load.
- Promote targeted outreach to the largest waste generators with the lowest recycling rates
- Continue to support and to provide incentives to those tenants with higher recycling rates.
- Implement a peer-based reporting system, in which each tenant could measure their recycling efforts alongside those of other tenants.
- Facilitate the switch to 100% durable and compostable serviceware inside the terminal.

Administrative waste made up 3% of the waste stream. The amount of administrative waste present in the waste stream on any given day may vary. Recommendations included:

- Target outreach and support to all ticket counters to provide education about the Port's recycling system.
- Provide assistance to other sources of administrative waste such as the Lost and Found office and TSA.
- Educate administrative waste generators about waste minimization practices such as double-sided printing, use of durable coffee cups, not printing emails unless necessary, etc.

The studied offered the following recommendations that apply to all source area generators:

- Incentivize tenants to minimize waste generation and comply with City of Portland and Port of Portland mandates. One possible option would be to implement a system to charge for garbage disposal while offering free recycling.
- Continue to coordinate among tenants, waste haulers, material processors, and compost facilities to negotiate better and more diverse recycling and waste minimization programs and practices.
- Continue to support those parties who are actively trying to improve their recycling habits.
- Provide outreach to large generators of waste that have comparatively lower recycling rates than their peers.

1. Portland International Airport; Liquid Collection Station Program

Focused Case Study

In 2009, Portland International Airport (PDX) created, developed and installed beverage collection stations to reduce the amount of liquid in the PDX waste stream. This program was established in response to a study which estimated that 90 tons of liquid waste is generated annually at security checkpoints. With federal regulations restricting beverages allowed through airport security, the stations serve as an innovative response to a persistent challenge. Based on measurements taken by janitorial staff that service the stations at both security checkpoints ABC and DE, PDX travelers divert between 5,000 and 8,000 pounds of liquid each month from the waste stream. Similar stations have now been installed at other airports across the country, and the Port of Portland has supplied graphics at no charge to other airports.

Program benefits include:

- Providing an opportunity for proper disposal of recyclable beverage containers
- Preventing the contamination of recyclables by reducing the amount of soiled paper
- Promoting the reuse of beverage containers
- Fostering a safer work environment for janitorial staff by reducing heavy lifting.

2. *Portland International Airport: Deplaned Waste Studies*

Focused Case Studies

In 2008, Portland International Airport (PDX) conducted a study to examine deplaned waste recycling opportunities. PDX examined a flight carrying 112 passengers between Orlando, FL and Portland, OR. Estimated total weight of cabin waste (garbage + recycling): 35.9 lbs. In total, it was seen that 63% of all possible recyclable materials were captured. These following types of materials were recycled: 1.0 lbs. plastic bottles; 0.3 lbs. aluminum cans; 6.6 lbs. of paper. However, it was noted there was substantial room for improvement with the following types of recyclable materials were left in the garbage: 2.3 lbs. plastic bottles; 0.3 lbs. aluminum cans; 2.1 lbs. of paper. Based on the waste composition, it was determined that flight attendants had the opportunity to recycle 35% of this aircraft's cabin waste: paper (24%), aluminum cans (2%), and plastic bottles (9%). They ended up recycling 22% (See data table below for types of materials and exact weights.)

Waste Material	Total Weight (lbs.)	Amount Recycled
Paper	**8.7**	**6.6 lbs. captured**
Aluminum Cans	**.6**	**0.3 lbs. captured**
Plastic Bottles	**3.3**	**1.0 lbs. captured**
Compostable Food/Fibers	**4.6**	**n/a**
Non-Recyclable Containers	**18.7**	**n/a**
Total Recyclables (paper, cans, and plastic bottles)	**12.6**	**7.9 lbs. captured (63% of possible)**
Total Garbage (food waste, liquid, non-recyclables)	**23.3**	**n/a**

In a similar exercise, PDX also studied at a flight carrying 129 passengers from JFK to PDX and found that flight attendants had the opportunity to recycle 52% of the aircraft's cabin waste: paper, and that they recycled 38% (26 lbs. of materials recycled out of a total possible 35 lbs. of recyclable materials). Although there was room for improvement with some recyclable materials left in the garbage, 73% of all possible recyclable materials were captured including: 5.25 lbs. plastic bottles; 5.3 lbs. aluminum cans; and 15 lbs. paper.

For more information on PDX's waste management programs, visit www.portofportland.com/env_home.aspx.

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M. Seattle-Tacoma International Airport (SEA), Seattle, Washington

Food Court Recycling

The Port of Seattle introduced new collection bins to the public food court area as part of SEA's continuing efforts to reduce landfill-bound waste. Accompanying tabletop decals encourage food court diners to think about where they toss their trash. A recent waste study concluded that 44% of airport waste is compostable, and public areas generate nearly half of all airport waste.

Since the bins were installed, more than 50 tons of food scraps and other compostable material were collected and diverted from landfills. The food scrap composting program aims to test the feasibility of extending airport food waste composting collection programs to passengers. Collected compostable material is sent to a local composting facility that converts the food scraps and fibers into nutrient rich soil amendments for use in gardens and landscaping. Recyclables are also collected and sent to recycling facilities.

For more information on SEA's program, see www.portseattle.org/Environmental/Pages.

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N. Salt Lake City International Airport (SLC), Salt Lake City, Utah

Reducing Waste by Reducing Waste Liners

In 2010, it was determined that a change was needed in SLC's waste bin liner program. The incorrect liners sizes and multiple bags were being used, creating inefficiencies in the trash disposal program. Salt Lake City Department of Airports (SLCDA) incorporated a program where the liners were "right sized" to the specific capacity of the waste bins utilized at SLC thus reducing plastic liner waste and cost. Further waste reductions were accomplished by using color-coding to increase staff awareness of available recycling bins and types, by coding the liners with the type of use, and by utilizing a lower mil of plastic.

The waste bin liners were manufactured and delivered in a rolled product form that allowed for less intense energy during manufacturing (compared to flat pack), and the ability to stock more per case, resulting in reduced packaging. SLC maintained its relationship with the existing waste liner manufacturer who contracted with a local supplier to allow for 'direct and drop' shipments without necessary repackaging. This local relationship will help reduce the impact to the environment and SLC's carbon footprint by reducing deliveries, new supply orders, fuel consumption, and labor costs. Between 2010 and 2011, SLC saved over 500,000 cubic yards of plastic waste liner and an estimated $30,000 by "right sizing" and minimizing the liner thickness.

For more information on SLC's programs, see www.slcairport.com/environment.asp.

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O. San Diego International Airport (SAN), San Diego, California

Green Build Construction Waste Management Program

In late 2009, SAN began construction on the largest project in the history of the airport. The "Green Build" is a $1 billion dollar airport facilities expansion project designed to meet SAN's current and future demand for travel while improving customer service and serving as an economic stimulus for the San Diego region. Highlights of the project include 10 new aircraft gates, more comfortable passenger waiting areas, enhanced curbside check-in, more security lanes, expanded concessions, and a dual-level roadway to relieve curb-front traffic congestion by separating arriving and departing passengers. At the peak of construction, the project is anticipated to create approximately 1,000 construction-related jobs. Sustainability and environmental sensitivity are the hallmarks of Green Build. The airport is making every effort to recycle and reuse construction waste on-site. The project is designed to achieve LEED® Silver certification from the US Green Building Council and is expected to be completed in 2013.

In 2011, Green Build generated approximately 5,500 tons of waste. Approximately 94 percent (5,150 tons) of that waste was diverted from landfills. Where possible, C&D waste from the project, such as concrete, has been recycled and reused on-site. Diverting 5,150 tons of waste from land disposal saved the airport over half a million dollars in 2011 (recycling savings = 5,150 tons X $98/ton tipping fee if not recycled = $504,700).

1. San Diego International Airport: Green Waste Reduction And Xeriscape Program

Focused Case Study

SAN maintains its 12.5 acres of landscaping with a combination of drought-tolerant California-native grasses, shrubs, trees, and palms that also generate smaller amount of plant litter and debris. The native plants can be maintained with smaller amounts of fertilizers, pesticides, and herbicides than exotic plants. When grasses are used for landscaping, SAN uses Hybrid Bermuda grass, which requires one-third less water than normal fescue-type lawns and less maintenance. Any clippings that are generated during maintenance are left on the turf as an organic fertilizer, reducing the amount of green waste generated. All of the green waste collected from landscape maintenance activities is recycled into mulch or compost. The mulch is processed on site and used for ground cover and erosion control. The remainder of green waste is hauled off site, along with coffee grinds and pre-consumer kitchen waste, to a municipal composting facility. In 2011, SAN diverted 20 tons of green waste from disposal using these methods.

2. San Diego International Airport: Wood Pallet Processing

Focused Case Study

Broken or unclaimed wooden pallets are collected by SAN's waste hauler and transported to a municipal composting facility for processing. The pallets are converted to wood chips for resale to customers at $18.00 per yard. These wood chips can be used as proactive ground cover or decoration. For more information visit: www.sandiego.gov/environmental-services/miramar/greenery/woodchips.shtml.

The best management practices for pallets include the following elements:

- ***Reuse.*** Vendors delivering goods on a routine basis to the airport and their tenants can take and reuse the pallets.

- ***Recycle.*** Wood pallet recycling is a general term for the sorting, refurbishing, dismantling and remanufacturing of pallets for sale, as well as the grinding of wood pallets for feedstock for other wood-based products, such as fiberboard. Pallet recycling is a multi-billion dollar business in the U.S.

- ***Mulching/Composting.*** When wooden pallets reach the end of their useful life, they can also serve as feedstock for processing as mulch or compost.

For more information SAN's programs, see www.sandiego.gov/environmental-services/recycling/cd/cdbenefits.shtml and www.san.org/sdcraa/airport_initiatives/green_build/default.aspx.

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P. San Francisco International Airport (SFO)

SFO Solid Waste Management Program

SFO progressively increased the rate of recycling of solid waste from 51% in 2002 to 75% by the end of FY 2011. SFO is continuing to enhance the source separation operations with the aim of achieving the City's recycling goals of 85% by 2017 and Zero Waste (90% or more) by 2020. SFO estimates that solid waste recycling at the airport offset GHG emissions by over 2,600 tons in 2011. SFO's recycling rate of 75% does not include recycling of construction and demolition waste, which consistently exceeds 90% on major airport construction projects. SFO's solid waste management program includes waste reduction, source separation, and composting. Recent waste reduction achievements at SFO include the following:

- Included a clause in all food concessionaires lease agreements at Terminal 2 requiring the concessionaires to provide biodegradable food-ware
- Initiated an annual waste characterization study to better understand the composition of solid waste streams and evaluate progress in the recycling operations;
- Reduced water bottle waste by providing drains in pre-security checkpoint areas and water bottle refill hydration stations in post security areas.
- Installed electric hand dryers in restrooms to minimize the use of paper towels
- Improved off-site source separation of mixed waste and increased composting of biodegradable waste;
- Partnered with contractors to achieve over 90% construction waste recycling on major projects; and
- Monitored custodial staff and tenants to ensure proper segregation of waste at collection points and at temporary waste storage facilities.

In 2011, about 9,309 tons of solid waste was generated at SFO, of which 6,961 tons or 75% was recycled. SFO's recycled solid waste is composed primarily of food/compostable materials (39%), cardboard (14%), and paper (14%).

SFO credits the success in implementing these programs to the partnership and effective communication between internal and external stakeholder groups at the airport. All of the solid waste programs implemented by SFO are low cost or no cost actions, developed to promote recycling and waste reduction. At SFO, the costs of sending solid waste to a landfill or to a composting facility are equivalent. On-site sorting of recyclable materials is an added monetary benefit to the airport. All source separated materials are hauled off at no cost to SFO and SFO receives a payment from the waste hauler for some materials such as aluminum cans, mixed metals, glass, etc.

1. *San Francisco International Airport: Food Waste Composting Program*

Focused Case Study

The solid waste recycling rate at SFO has increased rapidly since 2007, due to improve on- and off-site sorting of waste, as well as the success of SFO's comprehensive composting program. SFO has been able to successfully transform a 2006 pilot food waste separation program into an ongoing large-scale composting program. In 2011, about 9,309 tons of solid waste was generated at SFO (slightly down from 2010's level of 9,928 tons), of which 6,961 tons or 75% was recycled. SFO's recycled solid waste is composed primarily of food/compostable materials (39%), cardboard (14%), and paper (14%). Currently, food waste along with biodegradable materials, landscaping trimmings, and wastewater treatment sludge is transported to off-site composting facilities. SFO also requires the use of biodegradable tableware, plates, containers, etc. by food vendors in all new leases and lease renewals. This measure enables the composting of 100% of the waste generated at SFO's food concessionaires. In 2010, SFO composted 3,623 tons of food and biodegradable waste, or 37% of SFO's total annual waste, increasing to 39% of total in 2011. The success of SFO's composting program has significantly contributed to the increase in the airport's overall solid waste recycling rate.

For more information on SFO's programs, see www.flysfo.com/web/page/about/T2/sustainability/.

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Q. Yeager Airport (CRW), Central West Virginia Regional Airport Authority, Charleston, West Virginia

CRW's Recycling Program

In 2009, Yeager Airport, in cooperation with the Kanawha County Solid Waste Authority, started recycling cardboard and paper. The cardboard and paper are collected on a daily basis by the buildings personnel and are picked up weekly by the Solid Waste Authority. Since 2009,

Yeager Airport has recycled over 50 tons of cardboard and paper products. This has resulted in substantial savings in landfill tipping fees. The Kanawha County Solid Waste Authority has also created another income source by bundling the cardboard and paper products and selling them on the market to help support the county-wide recycling program.

In 2010 and 2011, Yeager Airport converted one of the airport's runways into a taxiway. During this construction, almost 200 tons of concrete and blacktop material was recycled into perimeter patrol roads and access roads around the airport. This helped the airport save on construction costs by the contractor not having to haul the material off site and to find a disposal area for the material.

For more information on CRW's programs, see www.yeagerairport.com.

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Airport and Program	General Municipal Solid Waste	Food Waste	Restaurant Grease Waste	Green Waste	Pallet Recycling	Deplaned waste	Construction and Demolition Waste	Rubber Waste	Source Reduction	Liquid Waste	Hazardous Waste	Waste Auditing	Innovative Approaches /New Technologies	Stakeholder Communication/Training	Procurement
Boston Logan International Airport (BOS), Boston, MA															
Warm Mix Asphalt							x		x						
Chicago O'Hare International Airport (ORD), Chicago, Illinois															
Construction Waste Management Program							x		x				x	x	x
Guiding Construction Waste Management with the Sustainable Airport Manual (SAM) and Detailed Specifications							x							x	x
Denver International Airport (DEN), Denver, Colorado															
Waste Recycling and Waste Management Program	x	x											x		
Pena Boulevard Construction Waste Management							x		x						
Conducting a Waste Assessment (Waste Audit)	x											x			
Hartsfield-Jackson International Airport (ATL), Atlanta, GA															
Construction Waste Management Conveyor and Recycling							x		x						
John F. Kennedy International Airport (JFK), Port Authority of New York and New Jersey (PANYNJ)															
Construction Debris Recycling							x		x						
John Wayne Airport (JWA), Orange County, California															

Airport and Program	General Municipal Solid Waste	Food Waste	Restaurant Grease Waste	Green Waste	Pallet Recycling	Deplaned waste	Construction and Demolition Waste	Rubber Waste	Source Reduction	Liquid Waste	Hazardous Waste	Waste Auditing	Innovative Approaches /New Technologies	Stakeholder Communication/Training	Procurement
Recycling Programs	x						x								
Coffee Ground Composting Program		x													
Los Angeles International Airport (LAX)/Los Angeles World Airports (LAWA), Los Angeles, California															
Waste Characterization, Recycling and Waste Management Program	x			x								x			
Recycled Content Plastic Trash Bags	x								x						x
Minneapolis-St. Paul International Airport (MSP), Minneapolis, Minnesota															
Recycling, Reuse, and Composting Programs	x	x	x												
Hazardous Waste Management Recycling											x				
Oakland International Airport (OAK), Oakland, California															
Waste Reduction and Recycling Programs	x						x			x			x	x	
Philadelphia International Airport (PHL), Philadelphia, Pennsylvania															
Organic Waste Recycling Program	x	x					x							x	
Phoenix Sky Harbor International Airport (PHX), Phoenix, Arizona															
Construction Waste Management Program							x		x				x		
Runway Friction Rubber Removal Recycling								x							
Portland International Airport (PDX), Portland, Oregon															
Waste Characterization Study	x											x			
Liquid Collection Stations										x			x		
Deplaned Waste						x									
Seattle-Tacoma International Airport (SEA), Seattle, Washington															
Food Court Recycling	x	x												x	
Salt Lake City International Airport (SLC), Salt Lake City, Utah															
Reducing Waste by Reducing Waste Liners									x						x
San Diego International Airport (SAN), San Diego, California															
Green Build Construction Waste Management Program							x		x						
Green Waste Reduction and Xeriscape Program				x			x								
Wood Pallet Processing	x				x										
San Francisco International Airport (SFO)															
SFO Solid Waste Management Program	x	x					x			x			x	x	x
Food Waste Composting Program	x	x													
Yeager Airport (CRW), Charleston, West Virginia															
CRW's Recycling Program	x						x								

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