Analysis of U. S. Army Solid Waste Management Policy

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Army Environmental Policy Institute
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Abstract

This study identifies national non-hazardous solid waste trends and key Army issues and concerns. It emphasizes ways to promote integrated management, including appropriate data as well as planning and management tools. Integrated management is defined as a coordinated effort to implement the U. S. Environmental Protection Agency's pollution prevention hierarchy, which focuses on approaches to: reduce waste at the source, recycle, and develop innovative waste disposal programs. The study focuses on four areas of Army concern: improving methods for waste characterization and data collection, organization and management to facilitate integrated solid waste management (SWM), incentives for improving SWM, and better training and communication. It discusses ways to combine an Army-wide framework for planning with program guidance and tools for installation planning.

The analysis indicates that the Army should initiate universal SWM planning based on common definitions and data elements, with particular focus on integrated management and innovative approaches. It defines a spectrum of options, from highly decentralized programs to more uniform policy and programs with central control and guidance. Options are evaluated in terms of four criteria: improving the Army's knowledge and understanding of solid waste, consistency with the pollution prevention hierarchy, cost-effectiveness, and demonstrating leadership. Finally, for each alternative presented, the study outlines associated implementation issues and needs that would have to be addressed as follow-on activities.

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1. Introduction

This report offers a framework for improving Army solid waste management (SWM). Based on an overview of the current state of Army SWM, it identifies many problems, issues and concerns. Given these issues and concerns, and the level of available information, the paper defines a variety of approaches Army decision-makers might select to establish a firm foundation for a coherent Army-wide policy, and also to provide a framework for further policy development as appropriate.

1.1 Approach

This report was written for the policy-makers at the Headquarters, Department of the Army (HQDA) level, and also for policy-makers at installations. Chapter 1 provides a brief overview of the organization and objectives of this paper. The remainder of the paper is organized as follows:

Chapter 2, National Context, briefly summarizes the issues, problems and trends most important in SWM today. It describes an overall context for the paper. In large part, the Army is facing the same issues as the nation.

Chapter 3, Army Context, draws parallels to the national context. Broad SWM issues and concerns facing Army installations are assessed. In Chapter 4, these assessments are discussed in light of available management and technical tools. This assessment also provides the basis for the policy framework and alternatives found in Chapter 5.

Chapter 4, SWM Tools, explains the various tools Army solid waste managers might employ to design an integrated program. Though it includes a broad range of information of potential interest to HQDA and installation decisions, the key policy element is the first section on SWM plans. This chapter presents:

- Decision making, waste prevention, waste handling, and implementation tools (i.e., approaches, techniques, and technologies) available to design an integrated SWM plan

- A comprehensive picture to encourage holistic thinking about SWM, and to provide a resource for decision-makers to target selected topics of special interest
- A foundation for the policy alternatives presented in Chapter 5.

Chapter 5, Frameworks For Policy, lays out HQDA options to address the issues and concerns, and achieve the objectives, outlined earlier. It gives a broad range of policy alternatives that HQDA should consider to improve Army SWM. These alternatives take into account the diversity among installations and the probable need to take a phased approach to improving solid waste methodologies and programs.

Chapter 6, Implementation, tries to answer the question "what next?" by outlining some of the principle decisions, information, and guidance needed to implement each of the alternatives presented in Chapter 5.

Chapter 7, Conclusion, recaps the study by reviewing and discussing the major issues, concerns, and proposed solutions.

The discussion of Army SWM tries to integrate two levels of analysis, the general (Army-wide) and the specific (installation). The Army context presents an overview of Army practices and concerns, focusing primarily on Forces Command (FORSCOM), Training and Doctrine Command (TRADOC) and Army Materiel Command (AMC). This Army overview identifies issues and concerns that need to be addressed at the installation-level, based on guidance from Major Commands (MACOMs) and HQDA. The study finds that the Army's current methodology produces data that are unreliable for integrated planning and management. In both the national and Army SWM contexts, definitions for solid waste vary significantly across units, characterization of waste streams is often inadequate, regional and seasonal variations can be very significant, and system-wide data are inevitably flawed insofar as they eliminate these important differences.

The alternatives presented in Chapter 5 are for an Army-wide approach to SWM. They are based on general principles applicable to a variety of Army facilities. Army policy specifying detailed program elements to address installation-level problems would not be prudent—at least not without more reliable baseline data than is currently available. Therefore, only general alternatives are presented as the first step. Installation-level problems are addressed by this Army-wide policy approach by encouraging installations to perform the kind of data collection, planning, and management that they need to successfully address their SWM problems. This approach does not preclude adding specific policies as appropriate. Finally, the study identifies several broad issues that installations cannot resolve by themselves, issues that must be addressed by HQDA, the Department of Defense (DoD), or Congress. The alternatives and implementation discussions take these issues into account and suggest approaches for addressing them as well.

1.2 Objectives for Army SWM

To develop an Army SWM policy, objectives for identifying areas for concern and emphasis, and for assessing the broad parameters of a SWM program are needed. Four key objectives essential to SWM are knowledge and understanding, pollution prevention, cost effectiveness, and leadership.

Knowledge and understanding of SWM has a data component and an education/training component. This objective involves developing a reliable database for ongoing SWM planning, management, and evaluation. It also encompasses training and education on solid waste issues for individuals whose actions affect the overall success of Army SWM objectives. In raising awareness and understanding of SWM, the Army should foster a sense of responsibility toward the environment, and enable personnel to fulfill that responsibility.

Pollution prevention involves implementing the Environmental Protection Agency's (EPA) pollution prevention hierarchy to minimize waste at every level. It is a holistic objective that emphasizes anticipating and preventing environmental problems. Pollution prevention involves integrated planning, taking into careful account the waste stream and other regional conditions, and then using appropriate management incentives and technologies to reduce and recycle wastes to the greatest extent possible.

Cost effectiveness is achieved when program goals are attained at minimum cost over the lifecycle. Cost effectiveness ensures that Army resources are managed efficiently and that solid waste programs are managed to maximize long-term net benefits to the Army and the nation. In managing solid waste, the Army should minimize environmental costs and liability costs for non-compliance and remediation, as well as monetary and personnel costs of SWM.

Leadership has both internal and external aspects. Internal leadership is concerned with Army decision-makers' role in SWM, in setting clear policies, and in influencing and encouraging Army employees. Externally, the concern lies with the Army's role in SWM vis-a-vis other governmental and private entities. Army officials demonstrate leadership internally when they articulate clear, feasible, proactive goals for environmental stewardship in SWM and help to achieve those goals. Leadership requires a clear, persuasive articulation of Army policies and programs to external audiences as well. The Army exercises organizational leadership when it takes the initiative in developing and implementing innovative approaches in SWM locally and regionally. These approaches should address current problems and enhance the Army's ability to meet dynamic changes in SWM resources, market conditions, technologies, and restrictions, as well as changes in Army needs. Such initiatives should positively influence other governmental and private entities, and public perception.

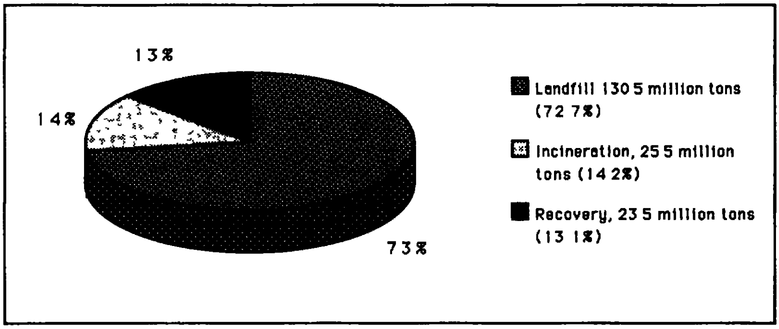
2. National Context

The United States is one of the top waste producing nations in the world. Waste generation, both per capita and total, in the United States has increased annually for more than three decades (EPA, 1990). Several issues contribute to this continuing increase in waste. U. S. citizens enjoy one of the highest standards of living in the world. The consumer market is highly developed providing consumers with an infinite choice of products. Additionally, products in the United States are often convenience oriented and heavily packaged (e.g. single serving food items). Also contributing to the waste generation are increased labor costs. Because making new parts has become cheaper than maintenance and repair, disposable products have become more popular.

Increasing costs have not curbed municipal solid waste (MSW) generation because disposal costs are often subsidized by taxes. In addition, most individuals can increase their waste disposal volume at no additional cost. Industries often manage or pay directly for their own waste removal, but even industry costs do not reflect full costs to the environment from processing, transportation, disposal, and long-term environmental consequences.

In addition to transportation, collection and disposal costs, true waste management costs include closure, liability, any environmental damages, human health effects, landfill depletion, and opportunity costs of the land used for waste management, as well as operation and capital costs for waste management. Another cost involves resource depletion. External costs include noise, traffic, odor, and property damage. As Figure 2-1 shows, most MSW is disposed of in landfills. U. S. solid waste generation is high, and relies primarily on disposal (rather than prevention) in part, because waste generators are not forced to pay the full costs. Without full cost information, municipalities, businesses and industries have no basis to evaluate the net benefit of waste management alternatives. Because some of these costs (e.g., noise) are borne by others, there is often little incentive to consider them, and solid waste managers may undervalue alternatives such as innovative source reduction and recycling incentives.

Figure 2-1 U. S. Municipal Solid Waste Handling



The number of landfills is decreasing even as the amount of waste increases. The number of landfills, however, is not necessarily a relevant measure of how much landfill time/space the United States actually has. Total capacity is the more relevant measure. Unfortunately, data on national landfill capacity is lacking. In general, most of the landfills that have closed or are closing are small and have fewer design safeguards. While fewer new landfills are being built, the new ones are much larger in terms of capacity. Most of the nation is not yet faced with a landfill crisis. Some areas, however, are experiencing a lack of capacity. Capacity problems result from negative public reactions to having such facilities located nearby (the "not in my backyard" or NIMBY syndrome), geologic inappropriateness of some sites for housing such facilities safely, and difficulty of finding large tracts of reasonably-priced land that are acceptable sites to the local population.

Land shortage is not the primary reason that the number of landfills is decreasing. Siting new facilities has become difficult in part because the public has become more concerned about risks or disadvantages that solid waste facilities may present. Scientific evidence has shown that public concerns are often exaggerated. Solid waste often receives a higher priority than its level of risk alone justifies. Public mistrust, however, involves an awareness of the inherent uncertainties of scientific evidence, including the possibility of human error and fear of unforeseen effects. In addition, given a choice, people oppose having a waste facility nearby. The public is often unwilling to accept external costs associated with odor, visual impacts, increased traffic, noise and air pollution from collection vehicles, and perceived declines in property values.

2.1 Legal and Regulatory Framework

Solid waste has become a popular topic among the public and regulators. Solid waste is receiving a tremendous amount of public scrutiny and many regulators are responding by making solid waste issues a priority on their agendas.

There have been increased efforts at the federal level to pass regulations on all aspects of SWM. The Resource Conservation and Recovery Act (RCRA) is the primary federal statute on solid waste. It is in the process of being reauthorized and draft bills are recommending more stringent requirements. Issues RCRA may address include interstate disposal, state SWM plans, recycling goals and developing recycling markets, and regulating non–hazardous industrial waste, as well as MSW.

RCRA gave the states the primary responsibility for handling solid waste and they have lead the way in developing solid waste requirements within a general federal framework. This exemplifies the fact that any solid waste option must be evaluated within the local milieu. No single program will work everywhere. State, regional and local regulations play a large role in determining what a SWM program will look like in any given area.

Other noteworthy federal actions include Executive Order 12780, signed in October 1991, and the pending Federal Facilities Compliance Act (FFCA). The Executive Order requires federal agencies to establish a program of reduction and recycling to cover all operations. It also includes stipulations for procuring items that contain recycled materials to the extent practicable. The FFCA, if passed, will expressly waive federal sovereign immunity under RCRA and require annual inspections of federal facilities. The Act is expected to pass in 1992.

2.2 Municipal and Non-Municipal SWM Differences

Municipal solid waste is defined as durable and non-durable goods, containers and packaging, food and yard wastes, and miscellaneous organic wastes from residential, commercial, institutional, and industrial sources (EPA, 1990). Non-municipal waste includes all other non-hazardous waste, such as oil and gas, mining, utility, medical, small quantity, generator, and agricultural wastes, as well as, sludge, combustion ash, and construction and demolition debris. (EPA, 1988).

The information presented in this chapter generally applies to both MSW and non-municipal solid waste. There are, however, a few differences that need to be noted. First, non-municipal solid waste makes up approximately 98 percent of all solid waste (EPA, 1990). Second, even though it constitutes the majority of all waste, less is known about the character of non-municipal waste streams and these wastes are less regulated than MSW. Little is known about the design, operation, location and environmental or health impacts of non-municipal waste disposal facilities.

Some non-municipal waste finds its way into municipal landfills and incinerators. There are also landfills and incinerators specifically for non-municipal wastes. In addition to these disposal options, non-municipal solid waste is often disposed in surface impoundments, land application units and waste piles, many of which are located on or near industrial facilities (EPA, 1988). Many generators also send wastes to permitted incinerators as a cautionary measure. Aerobic and anaerobic decomposition is used for some agricultural and food processing waste, some of which has beneficial uses but much of which goes to surface impoundments. Dry waste is usually transferred to landfills, piles, or land application units. Many industrial processes generate wastewater and sludges which can be transferred via water to surface impoundments for disposal. Surface impoundments can then be periodically drained, excavated, and the solids gathered for disposal. Other wet wastes can be de-watered and then disposed by one of the dry methods.

Many industries use on-site recycling or recovery of the waste stream for reuse in their industrial processes, as fuel for industrial processes, or for transfer to other industrial establishments. Again, however, little is known about how much or what types of reuse or recycling is actually occurring. Most waste recovered on-site is probably not included in the waste numbers reported.

2.3 Infectious Waste

Infectious waste, which constitutes a very small portion of the waste stream, has been the topic of much recent debate. Infectious or pathological waste is defined as medical wastes which have the ability to transmit disease-producing microorganisms. This includes blood, cultures, surgery and autopsy wastes, laboratory animal wastes, dialysis wastes, wastes from patients with highly communicable diseases, all used sharp instruments and equipment, and supplies which have contacted infectious agents (EPA, 1988).

These wastes do not currently fit into any of the traditional waste categories. They are not classified as hazardous, but are perceived to be more dangerous than non-hazardous solid waste. States have the lead in regulating these wastes, and the regulations vary widely. Twelve states require permits for treatment, transport and disposal; 31 have packaging and labelling requirements; and six have no requirements. Approximately 72 percent of the states recommend incinerating infectious wastes and 53 percent recommend autoclaving the wastes (Darcey, 1988).

2.4 Integrated SWM

Effective SWM requires an integrated approach which examines SWM as a total process. This means combining various waste management "tools" into an overall design. This report supports the EPA waste management hierarchy which establishes waste reduction and reuse as the first priority; followed by recycling; then safe treatment and disposal through incineration and landfilling. Effective SWM requires integrated planning to ensure maximum efficiency as well as environmental and economic viability.

No single approach, or combination of waste management tools, will adequately address national solid waste needs. Trade-offs among approaches are often neither obvious nor easy. Implementing any tool will have an impact on the applicability or usefulness of other tools. For example, including a waste–to–energy plant (one tool) in a solid waste program can affect source reduction and recycling plans (two more tools). Waste–to–energy facilities require certain levels of input each day to maintain their economic viability. Guaranteeing a certain amount of trash might be in direct conflict with reduction efforts. Recycling efforts can pull the high Btu items from a waste stream before they get to the incinerator, reducing the amount of energy the facility can produce. With careful planning, some programs have eliminated this conflict. There are examples, such as Madison, Wisconsin, where incineration works in conjunction with an aggressive recycling program.

Each management tool affects the environment in terms of the energy used, pollution generated, and raw materials consumed. An integrated approach should consider each of these steps: harvesting and processing raw materials; original processing or manufacturing; collection for reprocessing; reprocessing or remanufacture; disposal; and very importantly, transporting the product or material between these various stages of its lifecycle, from "cradle to grave." If all these factors could be considered for a product, then its total environmental impact, and not just its toxicity or volume in the waste stream, could be evaluated and compared to other options.

Establishing an appropriate balance between various waste management tools will require designing different programs for different areas. A key to creating an effective integrated SWM program is to evaluate the options within local constraints. Every aspect of waste generation, waste handling, and waste disposal can vary significantly among states, regions and communities. Differences can be attributed to regulations, prices, geography, and culture, among other factors. Even within a particular locale, solid waste can be a changeable creature. Seasonal variations as well as growth or decline within an area can play a significant role in developing management approaches or programs.

2.5 Source Reduction

According to the EPA hierarchy, the first objective for SWM should be waste prevention and reduction. Prevention focuses on reducing toxicity as well as volume. Prevention and reduction programs can significantly reduce natural resource consumption, direct and indirect treatment and disposal costs, and risks. Reducing the total amount and toxicity of waste generated will require changes not only in design and pricing, but in values and behaviors which will be challenging to both producers and consumers.

In this document, using EPA definitions, reuse is considered part of a reduction strategy. Reuse means taking components of the waste stream and, with slight modification such as cleaning or repairs, using it again for its original purpose; refillable beverage bottles are an example.

2.6 Recycling/Composting

The second objective for waste management is maximizing materials recovery. Recycling helps to ensure the maximum use of a resource by taking a used, discardable item and processing it to produce more of the original item, or another item. For example, aluminum beverage cans are crushed and remelted, then turned into sheet aluminum which can then be used to make more beverage cans, or airplanes, or any number of products. Compared to using virgin materials, recycling reduces natural resource consumption and, for some products, may reduce energy use and pollution rates.

This paper includes composting as a form of recycling. Composting is a process that allows microorganisms to decompose waste into a soil-like product. Composting reduces the volume of waste to be disposed in landfills and incinerators. The compost can also be marketed to a variety of users including landscapers and gardeners.

2.7 Disposal

The third objective for waste management is to safely and cost–effectively dispose of waste that cannot be recycled or reused. Although there are other non-municipal solid waste disposal methods (see Section 2.2), incineration and landfilling are the primary municipal waste methods. Incinerating MSW may be a feasible way to reduce volume. Incineration in conjunction with heat recovery can reduce natural resource consumption. There are, however, concerns and considerable controversy associated with incineration, particularly the safe handling and disposal of incinerator ash, and air quality issues.

Finally, landfilling solid waste, both municipal and non-municipal, is still necessary even if maximum waste minimization and recycling goals are achieved, and waste is incinerated. For some wastes, landfilling is the most appropriate disposal option. There are many kinds of landfills, some owned and operated for industrial wastes and some owned and operated for municipal wastes. While landfills are used for most MSW, technical requirements for siting, operating, and closing them have grown increasingly stringent. Since 1978, 70 percent of landfills have closed, with one-third to one-half of the remaining 6,000 estimated to close within five years; between 1985 and 1990 there was a 50 percent decrease in the number of new landfills compared to the previous five years (OTA, 1989). Other kinds of land-based disposal methods (surface impoundments, piles) are widely used for non-municipal solid waste.

2.8 SWM Trends and Forecasts

Public interest, knowledge and concern about solid waste have increased rapidly in recent years. The philosophy of SWM, as well as environmental issues in general, is changing across the county. These changes are beginning to be reflected within the regulatory communities. Federal, state, and local regulators have increased their attention to solid waste issues. Section 2.1 discusses some of the most pertinent regulatory activities.

Solid waste regulations are increasing in number and stringency. Combined with increasing public opposition, this is causing costs for all facets of SWM to rise dramatically. The idea of full cost accounting is also being widely discussed to better incorporate environmental considerations in planning. Industry is paying more attention to SWM. Reducing the volume or toxicity of waste streams can produce savings in materials recovery and in disposal costs for industry. Further, industry is finding that solid waste reduction strategies can be effective for marketing consumer products.

Experiments are being conducted at the local and regional level. This includes efforts to try various facility mixes as well as experimenting with collection, transportation, and disposal methods. The assignment of responsibilities for various aspects of SWM, ways of developing various markets, and ways to present public education programs are also being addressed. The number and variety of recycling programs has been expanding rapidly, with attempts to seek new markets for recycled and recyclable materials.

The technology for SWM is changing quickly. Several recent developments and approaches have been subject to uncertainty and are currently in the testing process. Examples include mixed waste composting, using tires as a fuel source, leachate testing and management, new incinerator technology, and digging up old landfills to recycle or reuse the contents.

2.9 Summary

U. S. solid waste generation is increasing (according to EPA, from about three pounds per person 10 years ago to almost four pounds per person today), and landfill space is becoming more difficult and more costly to expand. Integrated SWM is the current approach believed to provide workable alternatives to our traditional reliance on landfills. An increasing number of communities and states are adopting SWM programs and plans that follow the EPA hierarchy of finding ways to reduce and recycle before considering disposal options of incinerating and/or landfilling.

The public has been educating itself about solid waste issues. Regulators are responding to public concern about solid waste risks (whether warranted or not) and to local opposition regarding siting decisions. Regulations are increasing in number and in stringency, and at the same time, the technologies for and expertise on solid waste issues are increasing rapidly. Many new developments are as yet untested, and the professionals are challenged to remain abreast of these issues and techniques.

There is currently a tremendous push for information and for solutions to solid waste issues. There do not appear to be any quick fixes to the growing solid waste problem. These challenges are complex and the answers may be as diverse as the regional conditions and issues the nation faces.

3. Army Context

3.1 Overview

Army installations face SWM challenges similar to those facing local municipalities. These problems include maintaining compliance to increasingly stringent solid waste regulations at the state and federal level; reduced capacity at remaining landfills and increased costs in developing and operating new disposal facilities; inadequate integrated planning; and inadequate characterization of solid waste streams for effective planning. If these problems are not addressed in the Army, they may result in disruption to installation activities, particularly in the face of increased RCRA requirements and increased scrutiny under the pending FFCA.

To address these challenges, many states and municipalities are actively monitoring solid waste generation to develop integrated SWM programs. The Army can learn from these successful solid waste programs. Two key elements important to successful SWM are:

- Accurate characterization of solid waste generation, composition, and costs
- Integrated solid waste planning and management.

It is difficult to make generalizations about Army solid waste generation and composition because the Army's current methods produce baseline information that is often inadequate or not comparable across installations. Solid waste generation and composition are roughly estimated using different definitions and techniques across installations. For example, some installations estimate generation based on tipping fees. Because tipping fees only indicate the number of trips to the landfill and volume of the disposal truck, this procedure could overestimate the actual solid waste generation. Some installations estimate composition based on one sampling of the waste stream, which does not identify seasonal variations in waste composition. Some installations do not attempt to systematically characterize their waste stream at all. Accurate waste generation and composition information is vital to successfully planning and implementing SWM programs.

Although SWM plans are mandated under Army Regulation (AR) 420-47, there are currently no Army policies to effectively implement integrated SWM in a hierarchical fashion as outlined in Chapter 2. Integrated planning and SWM is difficult because good data are lacking and solid waste responsibilities are fragmented within the Army. While the Director of Engineering and Housing (DEH) has overall responsibility for SWM; recycling, landfill operation, and incinerator operation are managed by three or more different offices on some installations (e.g., Directorate of Personnel and Community Affairs (DPCA), the Environmental Office, and Utilities), each with different goals. SWM responsibilities are also somewhat fragmented at HQDA and DoD. Implementing integrated SWM requires close coordination between responsible offices that often does not exist across Army offices, installations, and commands.

Another reason it is difficult to make generalizations about Army solid waste generation is that installations have different missions and are widely distributed throughout the nation and the world. There are a total of 28 Army divisions with 22 divisions located in the Continental United States (CONUS). Within the United States there are a total of 501,470 active Army personnel with 762,067 dependents at 71 major installations in 26 states (Profile of the Army, FY90). TRADOC, FORSCOM, and AMC, the major Army waste producers, are the focus of this paper. However, many of the problems and corresponding strategies are applicable to other Army commands.

There are distinct differences in solid waste generation between troop–type installations and Army industrial installations. Within CONUS, TRADOC and FORSCOM have large "troop-type" installations. There are 20 TRADOC installations and 23 FORSCOM installations, including those installations designated for base closure. Troop-type installations can be similar to small cities with transient populations (e.g., university communities). Waste composition at these installations varies depending on their mission and size. Some installations have periodic influxes of personnel, particularly training installations that host National Guard (NG) and Reserve units.

Army industrial installations within the AMC have waste characteristics comparable to industrial complexes that can generate large amounts of special and hazardous wastes. There are approximately 62 AMC facilities with a variety of different missions such as weapon depots, armament manufacturing, weapons test and evaluation sites. Approximately one third (23) of AMC facilities are government owned contractor operated (GOCO) with the other 39 installations being government owned government operated (GOGO).

The Army Reserve, a command under FORSCOM, and the NG also contribute to total Army solid waste generation and have unique problems with waste disposal. The Reserve has at least 1500 centers nationwide used for weekend training. It uses FORSCOM installations for periodic training and contributes to the waste stream of those installations. There are approximately 447,300 personnel in the NG located nationwide. The NG train on state-owned lands and occasionally on federal Army land. The NG must comply with Army SWM regulations (AR 200-1) whether on state or federal land. The Reserve and NG do not generate significant amounts of municipal waste compared to the active Army. However, they do have to dispose of industrial materials (e.g., used oil, lubricants, solvents) used for servicing vehicles and equipment. The Defense Reutilization Marketing Office (DRMO) is responsible for collecting many of these materials and often does not have the resources to collect from the many Reserve and NG centers located across the country (Puryer, 1992). Reserve centers also have difficulty in initiating recycling programs because of limited staff and space for recycling containers.

3.2 Army Solid Waste Stream

3.2.1 Army Solid Waste Generation

The Army's current methodology does not allow reliable characterization of solid waste generation and composition. Currently, the Facilities Engineering and Housing Annual Summary of Operations (Redbook) provides the only consolidated source of data for solid waste collection and disposal. These data were gathered from installations without standardized guidance or definitions for estimating solid waste generation. Discrepancies result from inconsistent use of solid waste definitions, inadequate waste characterization methods at the installation level, and unclear purpose for the data. Therefore, generation estimates are not comparable among installations and aggregate estimates in the Redbook are unreliable. The Redbook data, however, may be of some help in comparing waste characteristics across MACOMs. According to the Redbook, troop installations (TRADOC and FORSCOM) collected 13.46 million cubic yards (CY) in FY90, while AMC installations reported collecting 2.93 million CY in FY90.

Another estimate of Army waste generation could be derived by multiplying total CONUS Army personnel and dependents times the national per capita estimate for waste generation. There are a total of 501,470 active Army personnel in CONUS with 762,067 dependents, which totals 1,263,537 people who could be contributing to the Army solid waste stream (Profile of the Army, 1990). Using an EPA per capita estimate of MSW generation of .88 tons/person/year, maximum total Army waste generation could be estimated at 1.11 million tons/year. The Redbook figures estimate CONUS annual collection to be 19.28 million CY, which translates into 6.42 million tons, assuming that three cubic yards equal a ton (Pettit, 1989). However, a per capita estimate of 1.11 million tons may not be valid because many families live off base and use off-post MSW collection and disposal services. Also, national per capita estimates do not adequately reflect the waste patterns of the highly transient installation populations and are not applicable to most AMC industrial facilities.

3.2.2 Non-Municipal Solid Waste

The Army produces a significant amount of non-municipal solid waste resulting from construction debris, sludge from wastewater treatment facilities, industrial activity, coal–fired power plants, and incinerators. Nationally, non-municipal solid waste accounts for approximately 98 percent of the total waste stream (OTA, 1989). The Army currently does not have the data to determine the percentage of non-municipal solid waste, but AMC might reasonably have more than 98 percent non-municipal solid waste. AMC generates industrial waste by producing munitions, tracked vehicles, and explosives; by storing weapons and supplies; and by demilitarizing and modifying ammunition.

Like the civilian sector, Army installations know even less about their non-municipal solid waste generation than they do about their MSW. Some construction and non-hazardous industrial waste are assumed to be reflected in the Redbook solid waste figures. However, construction waste is often taken off the installation by contractors and is not monitored. Many installations have construction debris landfills, although accurate estimates on the number or capacity of non-municipal landfills are not available from the MACOMs.

The importance of addressing these wastes can be illustrated by the issue of disposing of asbestos or construction debris contaminated with lead-based paints. EPA has proposed regulations (57 FR958; January 9, 1992) to require toxicity testing for construction material with lead-based paint. Materials that fail the test would have to be disposed of as hazardous waste. This would significantly increase disposal costs for lead-contaminated construction debris.

Further characterization is required for Army non-municipal solid waste to determine appropriate policy guidance. Each MACOM is currently planning waste characterization studies and these should include evaluation of their non-municipal solid waste generation.

3.2.3 Waste Composition

Waste composition at Army installations varies depending on a given installation's mission, population and geographic location. Overall, information on waste composition is not consistently available or reliable at all Army installations. Information on non-municipal solid waste composition is even sparser than MSW estimates. Several installations have had municipal waste surveys performed. Table 3-1 compares the Army solid waste composition figures to national composition figures.

Table 3-1 Examples of Army Municipal Solid Waste Composition (% of total)

Type	Fort McPherson (1991)	Ft. Lewis (1991)	National (1990)
Paper/Cardboard	41.0%	32%	35.6%
Aluminum	6.4%	2%	1.4%
Miscellaneous Metals	0.4%	3%	0.7%
Glass	0 8%	2%	7.0%
Plastic	4.6%	2%	8.0%
Yard/Food Waste	3.7%	16%	25.0%
Miscellaneous Trash	43.1%	43%	22.3%

Because composition varies across the Army, SWM approaches need to be tailored to waste stream characteristics. For example, Fort McPherson, an installation with a large transient population, has significantly less yard and food waste than the national average. However, large installations with predominantly active units stationed there could have waste similar to municipal compositions. Because of this variation in composition, SWM must be tailored for each Army installation. For example, composting may be feasible at Fort Lewis which has 16 percent yard/food waste but probably not at Fort McPherson which only has 3.7 percent yard/food waste. The best mix of source reduction, recycling, composting, and choice of disposal facilities will be greatly influenced by the unique composition of the installation's solid waste.

3.3 Army SWM Costs

In FY90, total CONUS solid waste handling cost the Army $49 million (Redbook, 1990). Of the three MACOMs, AMC has the highest unit cost (total cost/quantity) for solid waste due to the variety of industrial wastes managed. Again cost figures from the Redbook are of limited use because some installations include costs for equipment, manpower, and recycling, while others may only include costs associated with landfill operations or tipping fees. Redbook disposal costs for FORSCOM and TRADOC installations in FY90 ranged from $10 to $10.63 per ton. Although national costs vary significantly, these solid waste costs, based on Redbook figures, are well below national average disposal costs of $26.93 per ton in 1988 (Pettit, 1989). Disposal costs for AMC facilities were estimated at $18.2 per ton. Army solid waste costs are partially offset by recycling proceeds but these are usually not subtracted from SWM costs shown in the Redbook. In FY91 the Army (CONUS) received $10.85 million from recycling programs (DoD Resource Recovery and Recycling Program, FY91).

3.4 Solid Waste Policy and Responsibilities Overview

This section provides an overview of DoD and Army policies intended to ensure installation compliance with state and federal solid waste regulations. Army solid waste policy and initiatives have been primarily focused on seeking regional and cost effective solutions, maintaining compliance for disposal operations, and initiating recycling programs. It is the installation's responsibility to ensure compliance with solid waste regulations at the federal, state and local level. DoD and the Army have established solid waste policy to help installations ensure compliance while promoting resource recovery without jeopardizing natural resources or health (AR 40-5).

Current policies do not provide sufficient guidance to achieve a leadership role in SWM. As with most large organizations, current Army and DoD guidance is fragmented and overlapping. However, initiatives for improved integration are underway at the DoD level through the DoD Resource Conservation and Recovery Committee and at the HQDA level through a committee to improve solid waste policy coordination and guidance. Proposed Army policy requires SWM plans to reduce solid waste. Guidance should allow flexibility to deal with local constraints and take advantage of installation specific opportunities for source reduction, recycling, and disposal. Specific Army policy on source reduction, recycling, incineration, and disposal will be discussed in further detail in Section 3.5. Table 3-2 reviews Army and DoD policy and regulations and the areas of waste management they affect.

Installations need further guidance to develop integrated SWM and gather the necessary data for effective planning. Proposed DoD policy is calling for consistent waste measurement by weight. As many as one-fourth of the Army installations do not have the capability to weigh solid waste as proposed by the policy. Purchasing adequate equipment would cost about $3 million and could take as long as two years to install.

Another important aspect of solid waste policy is how solid waste initiatives are funded. There are two sources of money for solid waste: utilities and environmental funds. Utility funds are primarily designated for building and operating disposal facilities. However, environmental dollars are often requested through the 1383 process to fund solid waste initiatives that are necessary to maintain compliance to environmental regulations. Both state and federal environmental laws are increasingly requiring recycling and imposing more stringent disposal requirements, making it more difficult to fund innovative solid waste projects. Funding proactive initiatives such as source reduction is difficult using either utility or environmental funds. Such

Table 3-2 DoD and Army Solid Waste Policies

	Responsibilities	Minimization	Recycling	Incineration	Disposal
DoD					
• Memorandum for Resource Recovery Coordinating Committee DoD Recycling Policy for DoD Recycling Program(DRP), 20 Nov 1991	■	■	■		
• DoD Directive 4165.60: Solid Waste Management—Collection, Disposal, Resource Recovery, and Recycling Program, 4 Oct 1976	■	■	■	■	■
• DoD Instruction 7310.1 Disposition of Proceeds from DoD Sales of Surplus Personal Property, Jul 1989			■		
• DoD Memorandum 10 Oct 1989	■				
Army					
• AR 40-5 Preventive Medicine, 15 Oct 1990	■				
• AR 200-1 Environmental Protection and Enhancement, updated May 1991	■	■	■	■	■
• AR 420-47 Solid and Hazardous Waste Management, 1 Jan 1985	■	■	■	■	■
Sobke, John F., Major General, ACE, Memorandum, 19 May 1992				■	■
• Offringa, Peter, Major General, ACE, Memorandum, 5 Sep 1991					■
• TN 420-47-02 Installation Recycling Guide, 1 Sep 1991 (USA EHSC)			■		

project requirements are regarded as non-compliance related and rarely receive funds unless an installation funds them out of its scarce Real Property and Maintenance Account (RPMA) funds. Typically funds are only available to correct deficiencies for which an installation has already received a Notice of Violation (NOV). Greater emphasis on funding proactive solid waste initiatives would promote the development of more cost-effective and protective approaches.

Various DoD and Army regulations define duties and assign responsibilities to carry out solid waste policy formulation and implementation. General and specific responsibilities are spelled out in AR 200-1 and AR 420-47, although other DoD and Army regulations also define responsibilities. The revised AR 420-47 regulation will attempt to broadly identify and summarize all solid waste responsibilities. The following provides an overview:

- DoD components must implement the criteria listed in the requirements section of published EPA SWM Guidelines; current techniques and practices in the Guidelines are to be implemented when feasible (1976 DoD Directive).
- Assistant Secretary of the Army for Installation, Logistics, and Environment (ASA, IL&E) develops SWM policies and initiates proactive efforts to identify more efficient and cost-effective means of treating and disposing of solid waste. Overall SWM policy and program management responsibility rest with the Deputy Assistant Secretary of the Army for Installations and Housing (DASA, I&H). The Deputy Assistant Secretary of the Army for Environmental Safety and Occupational Health (DASA, ESOH) oversees the environmental aspects of SWM (AR 200-1, AR 420-47).
- The Office of Assistant Chief of Engineers (OACE) administers, directs, implements, and monitors the Army's solid waste program, including waste minimization. OACE also issues guidance to ensure Army commanders and managers are aware of legal, regulatory, reporting and operating procedures. The Army staff proponent for SWM is the Engineering and Housing Support Center (EHSC); the Army Environmental Office oversees the environmental

aspects of SWM. The Community and Family Support Center is responsible for overseeing non-appropriated funded recycling activities (DoD Directive 4165.60, AR 200-1, AR 420-47).

- Assistant Secretary of the Army for Research, Development and Acquisition (ASA, RDA) will establish policies directing the Army procurement, accounting, and reporting system to emphasize waste minimization through resource recovery, recycling, identification of requirements and specifications for source reduction, and waste disposal pursuant to Federal Acquisition Regulations (AR 200-1).
- ASA, IL&E, Corps of Engineers (COE), and Defense Logistics Agency (DLA) will implement materials substitution initiatives that will contribute to a reduction in solid waste (AR 200-1).
- Deputy Chief of Staff for Operations and Plans (DCSOPS) will evaluate the lifecycle costs of equipment for source reduction, material reclamation, resource recovery, recycling, and waste management. DCSOPS also authorizes and ensures that specialized personnel and equipment are available to support installation waste management (AR 200-1).
- Deputy Chief of Staff for Logistics (DCSLOG) ensures that the Army logistical staff maintain equipment to extend its useful life and to reduce and recycle wastes; ensures that material is designed, procured, and used to minimize the amount of waste generated; and coordinates with ASA, RDA.
- Major Commands (MACOMs) are charged with overall implementation schemes including: best method of disposal; efficient organization of collection and disposal; establishing waste management; developing resource recovery, recycling, and waste disposal programs according to AR 420-47; and reporting to HQDA.
- Installations: In addition to overall requirements to comply with federal and state standards, installations are charged

with establishing and executing programs, maintaining a database(s) of current information on recyclable markets, and monitoring to reduce amount of waste disposal by landfilling or incineration (AR 420-47).

3.5 Army SWM Programs

Integrated waste management combines several techniques to manage elements of the waste stream most effectively. The elements of the management hierarchy (source reduction, recycling, incineration, and landfills discussed in Section 2.4) are interrelated and can be designed to complement each other. Army solid waste programs vary considerably among installations in terms of management, operations, and overall effectiveness. In general, Army MSW and construction debris is landfilled and medical wastes (pathological and non-pathological) are generally incinerated. Other non-hazardous solid waste covers a wide range of categories and generalization is difficult; some of these wastes are managed by DRMO. The following sections provide an overview of current Army source reduction, recycling, incineration, and landfill programs.

3.5.1 Source Reduction

Source Reduction Policy

Current policies focus on waste stream reduction which differs from source reduction. Waste stream reduction focuses more on reducing waste at the end of the waste stream before it enters a landfill. Source reduction focuses on reducing the amount of material entering the waste stream and is the first consideration in the EPA pollution prevention hierarchy. DoD did adopt a directive (4165.60) stating that the military is committed to a rigorous schedule of minimizing waste and reducing solid waste materials at the source whenever possible. Existing Army solid waste guidance does not preclude source reduction, but focuses more on waste stream reduction. Additionally, it does not explicitly identify a management hierarchy with source reduction as the primary goal, followed by recycling.

DoD has been considering whether to issue a policy to reduce solid waste by 10 percent each year for five years using a baseline from calendar year 1992. This policy may be impossible to implement because baseline information on waste generation is often not available and definitions for solid waste differ. The Army encourages reducing the volume of the waste stream in Army Policy Memorandum for Obtaining Utility Services and AR 200-1. TRADOC has set a goal reducing every installation's landfilled solid waste by 50 percent by the year 2000 (COE, 1991). FORSCOM intends to reduce its waste stream by 25 percent in 1992, 35 percent by 1994 and 50 percent by the year 2000. Installations in other MACOMs are starting to set targets for source reduction, recycling, and purchasing recycled materials in accordance with the President's Executive Order 12780.

Source Reduction Programs

Source reduction can be achieved by activities such as designing production processes to minimize waste by-products; setting procurement requirements to use minimum packaging; conserving resources (e.g., copying on both sides of the paper), designing and using longer lasting, reusable, and recyclable goods; and educating military personnel to use low waste goods and services. Currently, there is only general guidance on source reduction in the Army. Tangible initiatives to reduce sources of waste may exist but are not common within the Army.

Current Army source reduction initiatives include DRMO programs to reuse materials (e.g., furniture, vehicles, office materials) and individual installation programs to minimize waste generation. It is unknown how much waste DRMO diverts from landfills with its reuse program. HQTRADOC has initiated a study using Fort Eustis waste generation to design a model to help reduce solid waste disposed at TRADOC installations by 50 percent by the year 2000. TRADOC, as part of the Tidewater Interagency Pollution Prevention Program (TIPPP), is working with the EPA and the DoD Commissary System to reduce sources of solid waste at DoD commissaries. As a test-bed for this initiative, EPA's Pollution Prevention Office evaluated Fort Eustis' new commissary to determine ways of reducing solid waste. Recommendations included buying in bulk to minimize packaging, and initiating educational programs to encourage installation consumers to buy environmentally "friendly" products. The Army might sponsor reviews for other installations to identify opportunities for source reduction. However, funding for pollution prevention efforts is difficult, because they are classified as Class III.

The Army should develop source reduction strategies in conjunction with recycling and disposal programs. Source reduction may become increasingly important if AR 420-47 is revised to include limitations on new landfills, as currently proposed. With a policy discouraging disposal facilities where regional alternatives exist, incentives for source reduction would be greatest in areas where disposal costs are high, such as in the northeastern states. Failing to plan source reduction could preclude certain strategies later, however, and could result in perverse effects if meeting short-term waste reduction or recycling goals depends upon the generation of certain wastes. Solid waste managers should also recognize that source reduction will help prevent future compliance problems (Class I and II) by reducing the total volume and toxicity of the waste stream.

3.5.2 Recycling

Recycling Policy

There are numerous state laws and DoD and Army regulations on planning and implementing installation recycling programs (see Table 3-3). DoD and Army regulations encourage installations to initiate recycling programs or to cooperate with local communities in existing recycling programs. Proposed revisions to AR 420-47 require recycling and encourage composting. All proceeds from recycling are regulated under federal law, DoD, and Army regulations. Technically any materials purchased with appropriated funds must be recycled through DRMO (EHSC, 1991). However, installations find that DRMO often does not provide the best price or will not accept some recyclable materials that local recycling programs will process (Dyer, 1991). Current DLA policies restrict a commander's ability to obtain fair-market prices for recycled materials, and may be contrary to installation management polices outlined in DoD Directive 4001.1, by inhibiting a commander's ability to implement an effective recycling program (Dyer, 1991). Materials from residential areas or other materials purchased with non-appropriated funds can be recycled in

Table 3-3 Recycling Regulations

Type	Regulation	Requirement
Planning	Military Construction Codification Act (P L 97-214)	Provides installation incentives to establish and maintain recycling programs
	Executive Order 12780	Federal facilities shall initiate cost-effective waste reduction and recycling programs
	AR 200-1	• Solid Waste will be be recovered and recycled to the greatest extent practical Recycling efforts will emphasize waste stream reduction and closed loop recycling approaches
	DoD Directive 4165 60	• Contracts for SW disposal services are required to include provisions for recycling whenever feasible • DoD facilities generating 100 tons or more per day of residential, commercial, and institutional solid waste shall establish and/or utilize resource recovery facilities • DoD facilities located within a Standard Metropolitan Statistical Area (SMSA) are required to participate with other DoD components and federal facilities in establishing single resource recovery facilities
Proceeds and Costs	TN 420-47 02	The sale of recyclable materials that were originally procured with appropriated funds is the responsibility of DRMO
	DoD Instruction 7310 1	Proceeds generated from sales of recycled materials will be returned to installations with Qualified Recycling Programs
	AR 200-1	• AR 200-1 also states how proceeds from recycling will be used
Interaction with Local Community	DoD Directive 4100 15	• DoD components shall not compete with a locally available commercial recycling industry which offers a total resource recovery system
	AR200-1	•Army installations that do not have their own established recycling program will cooperate to the extent practical in civilian community recycling programs
Use of Recycled Materials	DoD Recycling Policy Memorandum	DoD will promote recycling of material through affirmative procurement practices to encourage the development of economically efficient markets for products manufactured with recycled material
	EPA Regulations 40 CFR 247 248 250 253	EPA has passed regulations that encourage federal agencies to procure recycled materials
Clearinghouse	DoD Recycling Policy Memorandum	Develop clearinghouse for innovative SW ideas

local recycling markets. Improving recycling and providing greater flexibility at the installation level would require a DoD-wide effort to revise DLA policy on marketing secondary materials.

The DoD Resource Recovery and Recycling Coordination Committee is developing policy guidance to improve recycling and to comply with the October 1991 Executive Order 12780, which requires all federal facilities to initiate waste reduction and recycling programs. This DoD committee is broadening its responsibilities to address all aspects of SWM, and might provide a mechanism for addressing DoD-wide issues.

Recycling Programs

Recycling programs are not mandatory. The main criterion when deciding whether or not to have a recycling program is the revenue generated. TRADOC, FORSCOM, and AMC estimate that 90 to 95 percent of Army installations have some form of recycling program and that installation recycling rates vary from 2 to 33 percent. Recycling rates vary across installations partially because different definitions are used. For example, materials processed through heat recovery incinerators or appliances reused through DRMO are considered recycling at some installations and not at others. Under EPA's definitions, this is not recycling.

Some installations have pursued aggressive recycling programs selling recoverable materials in regional markets when they provide a better price than DRMO. Morale and Welfare offices, for example, can often get higher bids on resalable materials from vendors than the local DRMO and can collect payment in a few weeks. DRMO markets secondary materials on a national market which does not always provide the best price compared to local markets. In addition, it often takes 12 to 18 months to receive payment (Stehle, 1991). Installations have to pay DRMO to dispose of some recyclable special wastes such as batteries.

The Army Auditing Agency (AAA) reviewed 138 Army recycling programs and concluded that a "lack of clear guidance on recycling has caused the Army to fall short of its potential to effectively reduce its waste stream and generate income for recycling" (AAA, 1991). Of the programs reviewed, 88 recycling programs were managed by the DEH and 48 by the Directorate of Personnel and

Community Activities. The AAA review stated that DEH recycling programs focused on waste stream management and recycled only the items that are easiest to recycle. DPCA recycling programs seem to have higher participation rates and more active programs. The audit also found that tenant organizations at installations often do not participate in installation programs nor initiate their own programs. Regardless of who manages the programs, installation recycling programs are usually fragmented and not part of an integrated approach.

Lack of integrated planning can result in poor source reduction, inefficient recycling programs, and less than optimal operation of disposal facilities. Environmental benefits are maximized and economic costs reduced only when all the components of waste management are integrated.

The AAA study also found that there is no consistency in the items recycled from one installation to another and most programs are limited to a few high-value, easy-to-recycle items. These findings are not surprising because Army recycling programs are expected to be self-supporting, and reduced disposal costs are not part of the accounting, nor are savings factored into recycling program initiatives. Therefore, installations recycle only materials they can market for a clear profit. This contrasts with some municipalities that subsidize recycling programs from landfill tipping fees and other revenue sources. If the Army and municipalities used true cost accounting, they would factor the saved costs of disposal, reduced liability costs, and reduced landfill maintenance and closure costs, among others, into recycling decisions.

There are recycling success stories that illustrate what the Army can do. Fort Eustis, for example, recycles 22 percent of its waste stream. Fort Rucker sells its plastics to a local rug factory. Fort McCoy has been able to recycle petroleum products by sending them to a processing plant that incorporates the petroleum products into aggregate material that can be used for construction purposes. Aberdeen Proving Ground (APG) is currently developing a solid waste plan that will identify ways to increase use of recycled materials, maximize recycling efforts, and evaluate the feasibility of a composting program. Fort Lewis has a successful recycling program which incorporates central collection points and residential collection. Installations have shown that they can develop effective recycling programs when they understand waste generation, composition and local opportunities for marketing secondary materials.

3.5.3 Disposal

Disposal Policy

Given the cost of complying with increasingly stringent laws, Army installations are encouraged to use local utility services when the lifecycle cost of municipal facilities are 125 percent of an Army owned and operated system (Offringa, 1991). In keeping with this policy, the proposed revision of AR 420-47 encourages the use of municipal disposal facilities rather than building new landfills or incinerators on Army land. To follow the EPA pollution prevention hierarchy discussed in this study, such decisions should only be made within a holistic approach to SWM, which is currently not reflected in Army policy or programs. Current Army policy requires prior approval from HQDA before discussing the siting of a disposal facility on Army property with local or regional officials.

Incineration Policy

DoD policy is to use thermal plants when and where feasible to reduce the volume of solid waste landfilled and to produce energy otherwise wasted (DoD Directive 4165.60). Army Regulation 420-47 requires that installations design, operate and maintain thermal processing units to meet design requirements, but the regulation does not provide any guidance on design requirements. Many states have specific requirements for air quality protection, siting, and ash disposal for MSW incinerators.

Army Incineration Program

The Army has built seven MSW incinerators and one is under construction (Table 3-4). Of the seven incinerators, only three are still in operation. Army incinerators have been plagued with cost-overruns and difficulties in meeting environmental regulations. In addition, ash from incinerators is often hazardous and requires special disposal in some states. This issue has produced conflicting circuit

Table 3-4 U. S Army Incinerators

Installation	MACOM	Status
Fort Dix, NJ	TRADOC	Open with an expected lifespan of 18 years.
Fort Eustis, VA	TRADOC	Closed in 1988 due to environmental concerns over ash disposal.
Fort Leonard Wood, MO	TRADOC	Closed in 1991 because facility could not comply with new CAA requirements.
Fort Knox, KY	TRADOC	Closed/date of closure not available.
Fort Rucker, AL	TRADOC	Closed in 1985 because of economic and environmental considerations.
Redstone Arsenal, AL	AMC	Land excessed to city and operated by city.
Aberdeen Proving Ground, MA	AMC	Land owned by Army/operated by county.
Fort Lewis, WA	FORSCOM	80% complete/new funds not available until FY94.

court decisions in the Second and Seventh Circuit Court of Appeals, on whether MSW incinerator ash is exempt from Subtitle C of RCRA. This issue will most likely go to the Supreme Court because of these two conflicting rulings in the lower courts. Congress might address this issue as part of the RCRA reauthorization; it is currently part of the debate.

The only new Army incinerator planned (at Fort Lewis) has been delayed by contractor problems and insufficient funds. Three operating incinerators (Fort Dix, APG, and Redstone Arsenal) have operated efficiently and without significant environmental compliance problems. Fort Dix has a heat recovery incinerator that uses manual separation to filter out recyclable and noncombustible materials.

APG has entered into a 20-year regional agreement with Harford County to operate a heat recovery incinerator on APG property. This incinerator disposes of waste (115,000 tons of refuse and 3,600 tons of tires annually) from many areas. APG sends its MSW to the incinerator at no cost and buys back 453 million pounds of steam annually, which is used for heating and other industrial needs. The energy produced at this plant saves approximately four million gallons of oil annually. Redstone Arsenal has also entered into a regional agreement with the city of Huntsville. Under this agreement the Army excessed 20 acres of land to the city which then built a heat recovery incinerator. Like the APG facility, Redstone pays no tipping fee and buys back steam from the facility.

The Army also operates 33 small incinerators at major Army hospitals to dispose of medical waste (Jones, 1992). Most Army medical waste incinerators were designed only to burn pathological waste. A common operational problem is that most hospital incinerators also burn non-pathological waste (e.g. swabs, cloth, bandages)which could be disposed of by other methods. Burning non-pathological waste increases the Btu value of the waste and shortens the lifespan of the incinerator. The Army Environmental Hygiene Agency (AEHA) is evaluating alternatives that can safely dispose of medical wastes, thus addressing the problem of poor incinerator operation and the increasing costs of retrofitting small scale incinerators with clean air technologies.

Landfill Policy

The EPA issued new criteria (40 CFR 258) for MSW landfills in October of 1991. As the Army considers how best to comply with these landfill rules, HQDA has reiterated its policy to obtain utility services from local, regional or private utility systems rather than having its own. Based on lifecycle cost analysis, installations have the authority to use regional or private landfills when the lifecycle costs are under 125 percent of the operation and maintenance costs of Army-owned systems. Otherwise, HQDA approval is required (Sobke, 1992). Under proposed revisions to AR 420-47, expansion of existing Army landfills will also require HQDA approval.

Table 3-5 Army Disposal Characteristics

MACOM	TRADOC	FORSCOM	AMC	Total
On-base	9	14	28	51
Off-base/contractor	10	17	27	54
On and Off	0	0	2	2
Furnished by Navy	0	0	2	2

Source EHSC 1989 (On and Off = installations disposing of MSW on and off post)

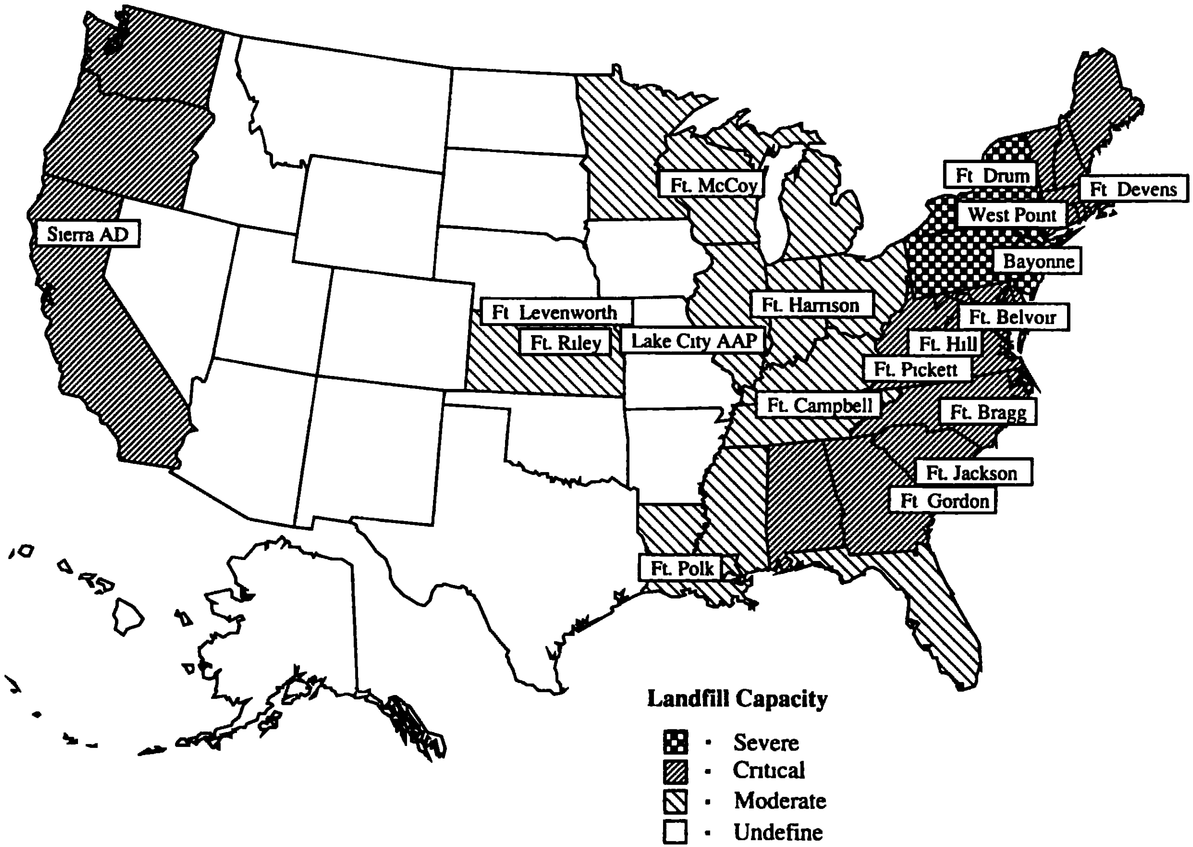
Landfill Programs

The Engineering and Housing Support Center (EHSC) recently performed a survey of Army landfills and estimated that TRADOC, FORSCOM, and AMC currently have 51 active solid waste landfills on base and use 54 landfills located off Army property (Table 3-5). Most Army landfills are designed with a 20-year lifespan but typically last only eight years because installations cannot afford or have not purchased trash compaction equipment. A lifespan capacity study of 48 selected Army installation conducted in 1989 by the U. S. Army Construction Engineering Research Laboratory (USACERL) found that 11 installations had a one to five year landfill life expectancy, seven installations had six to ten years of remaining capacity, 14 had more than 10 years life remaining, and 16 installations had no active landfills (Griggs, 1991).

Figure 3-1 shows installations with landfill capacity less than 10 years overlaid with national landfill capacity. Three installations with limited remaining landfill capacity are located in areas with severe landfill capacity shortages (no remaining/available landfill space) and seven installations are located in areas with critical shortages of landfill capacity.

All 51 Army sanitary landfills must have state approved permits to operate. States are requiring more stringent standards for operation before renewing landfill permits. New permits must meet EPA's October 1991 landfill standards, which are significantly more stringent. HQFORSCOM has estimated that 80 to 90 percent of its landfills would not meet the next round of permit requirements without some upgrading.

Figure 3-1 National Landfill Capacity Overlayed with Army Landfills with Less Than 10 Year Capacity



Source: Griggs, 1992

An expert from AEHA estimates that approximately 50 percent of Army landfills may close by October 1993 because of new EPA RCRA landfill regulations (Bauer, 1992). After 1993, significant new requirements (40 CFR 258) will be imposed on operating and closing landfills (e.g., leachate monitoring, methane gas, and groundwater monitoring); this provides a strong economic incentive to close landfills lacking these systems before the effective date.

3.6 Compliance

The most common Army solid waste compliance problems are related to operational deficiencies such as failure to provide daily cover or fencing at landfills (Bauer, 1992). Another common compliance problem results when installations find their landfill has reached capacity and they have no other viable alternatives. Many states will not issue a new landfill permit until detailed siting investigations are completed, alternatives are explored, and the public is informed. Installations often do not begin investigating future solid waste disposal options until the current landfill is practically full. When installations suddenly realize they are running out of landfill capacity, the time required to perform adequate environmental studies, and obtain approvals and permits is often not sufficient to meet compliance or permit expiration dates. As noted previously, Army landfills often do not achieve design capacity because of a lack of compaction equipment and inadequate waste stream monitoring.

There are 15 Army National Priority List (NPL) sites (under Superfund) where landfills or waste lagoons are contributing to contamination (see Appendix A). Most of these NPL sites are located at AMC facilities that landfill industrial waste. Overall, Army municipal landfills at troop-type installations have had relatively few environmental problems (Bauer,1992). In 1986 AEHA conducted an evaluation of groundwater quality near solid waste landfills at selected Army installations (AEHA, 1986). The evaluation concluded that ground water quality beneath the 30 Army solid waste disposal sites met federal drinking water standards. However, it should be noted that new problems might arise. The AEHA study was based on state groundwater requirements, which looked primarily for targeted pollutants such as heavy metals and nitrates. State groundwater standards for landfills are tied to EPA water standards, which have been evolving; EPA has now listed more organics, for example. Most Army landfills have not monitored for these pollutants. Problems could arise where old landfills are still in use, or if new landfill cells (meeting the latest requirements) located next to old cells, leak some of these previously unmonitored organics (Bauer, 1992).

As landfills close, FORSCOM is expecting to find more contaminated landfills. AEHA has conducted 75 to 80 solid waste audits of installations and has identified the most common problems in the operation of Army landfills to be: not applying daily cover, not grading properly, and allowing blowing litter.

AEHA considers lack of training for landfill operators to be the primary cause of these problems (AEHA, 1986). Currently, there are no Army training programs for landfill operators. However, both TRADOC and FORSCOM plan educational programs for SWM that might address landfill operations within the next two fiscal years.

Another indicator of compliance are Environmental Compliance Assessment System (ECAS) audits, which AEPI is currently analyzing to determine systemic problems. The initial findings of this study are that operation and maintenance problems result in the greatest number of violations. Another interesting aspect of this analysis is that recycling problems are starting to be identified in ECAS audits because of the increasing number of state, federal, and Army regulations that mandate recycling.

3.7 BRAC-SWM Issues

Base realignment and closure (BRAC) decisions will affect SWM at installations that are closing or receiving additional personnel. Closing installations will have to ensure that landfill closure operations comply with state and federal laws. Installations losing personnel will have to consider whether reductions will critically affect existing SWM approaches. For instance, incinerators are designed with minimum inputs of MSW and reducing personnel may reduce the operational and economic viability of the facility. Receiving installations will have to reevaluate their management of solid waste to ensure disposal capacity is sufficient to meet new demands.

The OACE, Installation Planning Branch, is developing a carrying capacity assessment program for the Army to evaluate the ability of an installation's infrastructure and natural resources to accommodate additional Army activities. One component of this program will be to design a systematic way to determine the impacts of realignment actions on SWM.

3.8 Solid Waste Initiatives

The Army has several initiatives underway to improve installation SWM. These initiatives include research to develop systematic ways of managing solid waste, gathering baseline information on installation solid waste, determining landfill capacities, and improving MSW incinerator design and operation. Although individual projects, the following initiatives have the potential to improve installation SWM.

- AEHA SWM Audit: AEHA established an audit protocol for comprehensively reviewing installation landfill capacity, regulatory compliance, landfill closure, collection systems, recycling program, and incinerators (if present).
- USATHAMA ECAS Solid Waste Audits: The U. S. Army Toxic and Hazardous Materials Agency's (USATHAMA) ECAS evaluates installation compliance with RCRA and state solid waste regulations. ECAS also will define remedial actions if an installation is not complying with solid waste regulations. ECAS will be automated within the Army Environmental Management Information System (AEMIS) by the end of FY92.
- USACERL Automated System for SWM: USACERL is developing a database to assist in integrating SWM. The objectives of this system are to: 1) define solid waste disposal options and their interrelationships for an installation; 2) assist in characterizing an installation's waste stream; 3) provide criteria for determining applicable recycling markets for material; and 4) provide algorithms for optimizing SWM alternatives.
- USACERL MSW Task Group: This task group is intended to develop an integrated approach to the management of MSW. The goals of the MSW Task Group are to: 1) identify

laws affecting SWM and determine their impact on installation practices; 2) assess reduction technologies; 3) conduct research in promising but undeveloped MSW reduction technologies; 4) establish rules for characterizing MSW flows and costs; 5) develop a method for designing and implementing environmentally sound MSW plans that will be cost effective and comply with regulations; 6) demonstrate MSW management at an Army installation; and 7) identify or develop an infrastructure for providing ongoing assistance to installations.

- FORSCOM Recycling Review: HQFORSCOM is surveying 15 of its installations to evaluate existing recycling programs and provide recommendations for improving recycling rates to meet FORSCOM recycling targets.
- TRADOC Waste Characterization Review: HQTRADOC is conducting a study of Fort Eustis to create a model for waste characterization at all TRADOC installations.
- AMC Recycling Review: AMC is also conducting a similar survey of its installations. AMC's study is intended to provide a comprehensive analysis of waste management programs, composition, and disposal methods.
- USACERL Incinerator Guidance: USACERL is developing guidance to assist installations in determining the feasibility of building an incinerator. This guidance is also meant to improve planning, design, and operation of Army incinerators.
- AEPI Environmental Trends Analysis: AEPI, as part of its environmental trends work, is developing strategies to monitor trends in Army waste generation and disposal capacity. This effort will include analyzing ECAS audits and NOVs to identify solid waste compliance trends.

3.9 Army Solid Waste Trends

Base realignment and closure decisions will significantly affect future waste generation. The Army's goal is to draw down active Army forces by 160,000 and reserves by 226,000. BRAC actions are closing 23 installations and 13 additional installations are proposed for closure (Profile of the Army, FY90). Army force reductions will decrease total waste generation. However, many installations will receive additional units from overseas, and within CONUS, and will face significant increases in waste generation.

A national trend is toward having fewer solid waste facilities which serve larger regions. As regulations for landfills and incinerators become more stringent, liability concerns for existing facilities rise, and siting becomes more difficult. As a result, larger facilities servicing a region will become increasingly common. Two scenarios are possible under this trend. First, government agencies, including the Army, could enter into regional agreements to plan, site, develop, and operate recycling and disposal facilities. This could result in improved economies of scale and possibly reduce long-term solid waste costs. Regional agreements are difficult to implement (see Section 4.4.1), but the Army has been successful at several locations. Where large disposal companies begin to have a monopoly on solid waste disposal in a region, higher disposal costs usually result. Where private competition is lacking, private sector prices have continued to escalate even when basic costs are not increasing (Bailey, 1992). With greater regionalization, Army activities would be subject to greater public scrutiny than if it operates its own facilities.

3.10 Issues and Concerns

In analyzing available data, AEPI found four underlying areas of concern: information collection and analysis, management and organization, incentives, and training/communication. These areas of concern and their corresponding issues help define a foundation for improving Army SWM. Table 3-6 identifies SWM tools (discussed in Chapter 4) that provide a starting point for addressing each of the issues. Army-wide guidance on how to use planning and implementation tools would help installations design effective programs. This discussion provides an overview of the major issues the Army might address by improving its solid waste policy guidance.

Table 3-6 Overview of Concerns, Issues and Tools

CONCERNS	RELATED ISSUES	APPLICABLE TOOL(S)
Information/ Analysis	What does the Army need to know to ensure effective SWM?	• SWM Plan • SW Handling Tools * • SW Prevention Tools
	How can lifecycle cost and environmental impacts be integrated into Army SWM?	• Cost Benefit Analysis • Market Incentives • Procurement Policy
	What definitions are needed to improve analysis of SW information?	• SWM Plan • SW Handling Tools *
Managment and Organization	What alternative forms of organization/management could enhance integrated SWM?	• See Alternatives Chapter • SWM Plan • SW Handling Tools *
	How should the Army increase SW source reduction?	• Source Reduction • Procurement Policy • SWM Criteria • Education/Awareness
	What, if any, new Army policy is appropriate to improve SWM?	• SW Management Plan • Establish SWM Criteria • Procurement
	What kind of planning is needed to improve integrated SWM?	• SW M Plan
Incentives	Who are the key players whose behavior is essential toimproving SWM?	• Education/Awarenes • SWM Plan
	What incentives would promote integrated SWM?	• Incentives • Education/Awareness
Training & Communication	What training do Army personnel need to improve SWM?	• Education/Awareness • Clearinghouse
	What intra-Army communication is needed to improve SWM?	• Clearinghouse • Education/Awareness
	What communication with local authorities and public is necessary to improve SWM?	• Education/Awareness • SW M Plan

* Waste Handling Tools include recycling, incineration, and landfilling

3.10.1 Information/Analysis

Accurate, internally consistent solid waste data are required at the installation level for effective management. Headquarters, Department of the Army needs accurate and comparable data on specific issues to monitor programs, develop guidance, and provide useful policy guidance. The Army needs to balance the cost of gathering data or improving data accuracy with the value of having accurate information for planning. Existing information and analysis on installation solid waste generation, composition, and disposal are generally inadequate for effective planning or lifecycle analysis at the installation; nor are they adequate for the HQDA level. In addition, guidance is not available to ensure accurate estimates of waste generation or composition. For example, data on recycling are often not comparable because different techniques were used in determining recycling rates and installations have different definitions of recycling. Without this basic information it is impossible for the installation to develop effective SWM programs and for MACOMs or HQDA to identify systemic problems, provide policy guidance, or set reasonable goals.

Another informational concern is estimating the full costs, sometimes called lifecycle analysis, for SWM approaches and for procurement decisions. When the full costs of alternatives and procurement decisions are considered, better evaluation of the trade-offs can be made. For example, the full cost of landfills are rarely identified because closure and post closure costs are not included in the total cost. The full costs of procurement decisions are not adequately reflected because disposal costs are not included in the total cost of the material. Understanding the lifecycle costs of products used within the Army would help incorporate waste minimization as a criterion for procurement decisions and identify the hidden costs of waste disposal. Full costs are not consistently used in SWM procurement decisions, and further guidance is needed to determine how full estimates may be used for improving decision making and promoting source reduction.

3.10.2 Organization/Management

Integrated planning requires command emphasis and commitment among the individuals responsible for waste management to coordinate programs. Without such commitment, various offices responsible for solid waste have different goals and perceive no incentive to coordinate or develop an integrated plan. A significant concern is that Army SWM efforts are not integrated. HQDA should clearly identify proponents to provide committed leadership, coordinate with DoD, and act as a catalyst to resolve issues beyond DoD's control. Fragmented installation management impedes integrated SWM. Perhaps alternative forms of coordination could enhance the Army's ability at HQDA and installation levels to exercise leadership in SWM by reducing reliance upon landfills, and to stimulate innovative approaches for waste minimization.

Current guidance does not provide a hierarchical approach for integrated SWM which would place a priority on source reduction. Resources are generally more available for cleaning up existing compliance problems than initiating proactive management strategies. Another issue is whether DLA policy should be modified to allow installations the flexibility to use local recycling markets when they provide a higher price on secondary materials purchased with appropriated funds.

3.10.3 Incentives

SWM in the Army lacks incentives to encourage integrated management. Research and policy guidance are needed to identify effective incentives to improve installation waste management, such as funding to encourage source reduction and recycling initiatives. Another related concern is how lifecycle costs could be used as an effective incentive to encourage long-term, cost-effective SWM that emphasizes source reduction.

3.10.4 Training/Communication

Training and awareness are related issues to developing effective incentives. Implementing incentives requires educating personnel, instilling environmental stewardship values that promote pollution prevention, and making personnel aware of incentives, how they apply, and the associated advantages or disadvantages.

The role of training goes beyond incentives, however, to improve installation SWM. While Army personnel should be made aware of how their actions affect solid waste generation and management, training is of particular importance for solid waste managers and technicians. Existing installation solid waste programs vary in their overall effectiveness. Better operator and manager training, increased command emphasis, and improved coordination within the Army on solid waste guidance and initiatives are essential. Finally, installation commanders must receive training on their SWM responsibilities.

Training is not a one time process, but should be an ongoing exchange of information, a source of information guidance dissemination, and a means to share innovative ideas. The Army needs to improve communication of solid waste initiatives to fully utilize existing resources, avoid duplicating efforts, educate installations on solid waste regulations and policies, and share success and failure stories across installations.

Effective communication is also needed between installations and the local communities and regulatory offices. Current Army policy encourages installations to participate in local agreements to handle SWM. This policy will make it increasingly important for installations to work closely with local, regional, and state solid waste authorities. Fostering good communication between installation and regulatory agencies will also be critical in obtaining and maintaining necessary disposal operation permits.

3.11 Summary

To improve Army SWM, the Army must clearly understand the issues upon which to build effective policies and strategies. This section identified four underlying issues: 1) adequate information is needed to manage installation solid waste and make policy decisions at the HQDA level; 2) Army guidance is needed to ensure effective integrated solid waste planning and management; 3) incentives are needed to improve SWM; and 4) training and improved coordination are needed to help ensure consistency in installation management. Tools for addressing each of these concerns are discussed in Chapter 4. These concerns and corresponding tools are applicable to all RCRA Title D wastes.

4. SWM Tools

This chapter identifies and describes four major categories of tools to improve Army SWM. These tools are decision making, waste prevention, waste handling, and implementation. When used together, these tools can facilitate integrated SWM and address the concerns identified in Chapter 3 (Figure 4-1). Army solid waste managers can use these tools to address their most critical needs. Decision making tools describe how to evaluate solid waste decisions and prepare integrated plans. The SWM plan provides the framework for utilizing all the other tools discussed in this section and is a key component of a successful program. Waste prevention tools identify approaches for reducing solid waste at the source. Waste handling tools provide approaches for recycling, incineration and landfilling. Once decisions have been evaluated and solid waste plans completed, implementation tools are available for working with MSW authorities, for training and education, and for developing a solid waste clearinghouse. Each tool discussion covers available approaches, how the tool could be implemented in the Army, its advantages and disadvantages, and any significant trends that might affect the tool's use.

Figure 4-1 Applicable Tools for Addressing Army Solid Waste Concerns

Tool Type	Decision Making			Waste Prevention			Waste Handling			Implementation		
Applicable Tool / Army Concern	SW Management Plan	Cost Benefit Analysis	SWM Criteria	Source Reduction	Incentives	Procurement Policy	Recycling	Incineration	Landfilling	Regionalization	Educ./Awareness	Clearinghouse
Information/Analysis	■	■									■	■
Organization/Management	■	■	■	■			■	■	■			
Incentives	■	■		■	■	■					■	■
Training/Communication	■										■	■

4.1 Decision Making Tools

4.1.1 SWM Plan

Approach

A SWM plan addresses present SWM needs, facilities, and activities; and sets out a program for the coming years. This tool is the integrative mechanism that should lay out how the other tools will be used and coordinated. There is no agreed upon content for these plans, and approaches can vary greatly in scope and level of detail. A plan's scope and depth, together with the accuracy of the underlying data and cost analysis, will determine its usefulness as both a guide to action and an evaluation tool. Because specific circumstances, waste characteristics, issues, and costs differ for each installation, each plan should be unique. For this reason, planning can best be done on a local level. Overall responsibility for plans should be clearly assigned. Installations (or Headquarters) could evaluate SWM results against planning goals. On the other hand, some generic elements critical to good SWM planning can also be identified. Installation plans should focus particular attention on the Army issues and concerns identified in preceding chapters. Without establishing minimum requirements or criteria, the quality and usefulness of these plans will vary tremendously. For example, AEHA's current efforts in preparing a guidance document for developing a SWM plan might provide a good basis.

In addition to tailoring plans for local use, a separate but important concern is whether individual plans are comparable. If the Army wants to establish and oversee some baseline of SWM quality, assure that installations are addressing Army concerns and issues, and identify areas to provide useful guidance, it is necessary to require a minimum level of complexity and consistency in individual plans. This includes establishing some common definitions and evaluation criteria. Finally, plans should clearly designate who is responsible for which elements, and specify means (an audit, for example) of evaluating accuracy or success. AEHA's experience with audits might provide a useful resource for defining essential categories. EPA has also published planning guidance (EPA, 1989).

Requirements for SWM plans could be designed to force installations to adopt certain program elements or practices. The main purpose of establishing minimum requirements is to guarantee that key terms are defined, certain data are collected as a basis for program choices, and key elements are considered. A secondary purpose could be to provide Army-wide information. As discussed in this paper, planning is defined as a tool to help assure integrated thinking, rather than to define specified outcomes. Table 4.1 presents a draft outline for SWM plans which includes the following elements: organization/management (including training), waste characterization, integrated SWM, costs, and issues.

There appears to be a national trend toward planning, on both a state and local level, although there has been no systematic assessment of their overall quality. Some states and localities see such plans as the best means to manage their wastes and also to control imported wastes. In fact, one proposed new RCRA provision would allow only states with SWM plans in place to put restraints on incoming solid waste. Along with the trend toward fewer, larger disposal facilities, one can expect to see more planning. Before siting new facilities, planners need to assure not only sufficient capacity, but also sufficient waste volume to meet minimum facility design needs.

Table 4-1 List of Potential Elements in SWM Plans

I Organization/Management

- Objectives of the program, in terms of the integrated SWM hierarchy
- Activities performed by Army, by contractors; who owns equipment (containers, trucks, disposal facilities, etc.)
- How SWM activities are coordinated across installations and jurisdictions
- Number of Army personnel assigned to SWM, their level and training; average hrs/week on various kinds of solid waste tasks
- Roles and responsibilities. who's in charge of what; who reports to whom—at the installation and state level
- How installation SWM responsibilities are incorporated into performance evaluations, what incentives exist
- Education/training/awareness programs (courses or activities offered, optional or required; number of hours/person)

- Feedback and evaluation mechanisms: Audit program and procedures, monitoring and evaluation program

- Outreach program (e g , to local organizations, government, etc.)

II *Waste Characterization*

- Current volume or tonnage of all solid waste, clearly separating municipal from other categories (see Section 2 2 for recommended definitions)

- Types of waste by volume/weight

- Seasonal variation· how it affects waste volume/composition

III *Integrated SWM*

- Mechanisms that assure effective integration across program components

- Source reduction and reuse activities

- Recycling program, if any; evaluate overall participation, effectiveness (include what is recycled, existing and emerging markets), describe any strategies for developing markets

- Kinds and amounts of recycled goods purchased

- Composting program, if any; describe overall participation, composition and effectiveness

- Disposal on or off installation? If on. kind(s) of facilities; are they permitted? If off: distance waste is transported, by what means, and who owns facilities

- How wastes are collected/stored (size of containers, locations), and how frequently collected

- Seasonal variation: how it affects storage and/or disposal

- Designed and remaining capacity at current facilities; current age and projected useful life for disposal

- New facilities needed within 5 years status of planning; on or off installation; proposed capacity, how minimum capacity needs will be met, coordinating with source reduction and recycling programs

- Closed landfills or incinerators: how many, how large, when closed, and why? What, if any, ongoing oversight occurs or is planned?

IV Costs

- Estimate costs in all SWM categories, including planning, personnel, training, equipment, upkeep (goal is full cost accounting, see Section 4.1.2)
- Funding plan

V Issues

- Projected (5-year, 10-year, 20-year) solid waste issues (including projected volume/tonnage) and likely changes in key factors
- Problems, including technical/R&D and compliance issues, and how installations will address them in the next 5 years
- Support that is needed from other Army elements
- Incentives/innovation projects
- Legal liability issues, and how they are being addressed

Advantages and Disadvantages

Developing good plans has several benefits. A good plan will help solid waste managers set and meet objectives, keep track of solid waste, and choose cost-effective approaches. As the factors affecting SWM are changing rapidly, it is necessary to plan comprehensively for future possibilities and needs. Developing an initial plan can be time-consuming and difficult, especially if baseline information is unknown.

The cost for developing a SWM plan will vary greatly depending upon its sophistication and accuracy. Some installations, for example, may not know the quantity or types of waste they generate. Costs also vary according to how extensive the plan is, and how successful planners are in gathering information from the various sources. Rough estimates from professional planners fall between $50,000 and $200,000; data collection alone can cost $30,000 to $40,000 (Becker, 1992). These cost estimates do not include implementation costs, but only the costs of planning, and the data collection necessary to do the planning. It is reasonable to assume that costs would be highest the first or second year of the plan. Army installations might incur less expense if data collection from Army personnel and contractors becomes easier. Some installations already have characterization studies underway. If guidance were available, some of the planning costs could be minimized. For example, if the plan called for an audit as an implementation or evaluation component, designing the audit could be rather expensive (AEHA and THAMA already have audit protocols). Some states have written guidance manuals for developing SWM plans. These efforts could be used as a foundation for Army guidance. Further, if the 1991 proposed Federal Facilities Compliance Act (FFCA) passes, audits might be the most cost-effective way to comply with its provisions.

For installations to remain in compliance and reduce their solid waste costs, comprehensive planning is essential. Planning provides a concrete way to address the Army concerns and issues outlined in Chapter 3. Planning based on knowledge of the major solid waste components, costs of handling, and alternative approaches gives managers a better idea of trade-offs and opportunities for increased efficiencies. Good planning facilitates more accurate waste estimates and disposal payments, and strategies for cost avoidance. Associated costs would be more than repaid through avoiding bad decisions and perhaps some costly surprises. Potential resource savings are too variable to estimate, but the absence of integrated planning can have very costly consequences (such as building an incinerator whose operation is not cost-effective in conjunction with aggressive source reduction and recycling programs). If the FFCA passes, waiving sovereign immunity, increased liability will be another reason to improve planning. Requiring a level of consistency across Army plans might increase upfront costs for installations, but such planning is an essential component of establishing an Army-wide policy.

4.1.2 Lifecycle Cost Analysis

Costs are an important consideration for SWM. Various strategies and tools have different short-term and long-term cost implications. Improper solid waste planning and management will either defer costs by increasing future costs to the Army, or externalize costs onto society. To select appropriate management strategies, the Army needs methods to compare alternative approaches, including ways to assess their relative benefits and costs.

Approaches

This discussion focuses on lifecycle costs and full costs. Lifecycle and full cost information would facilitate weighing the benefits and costs of decisions to help ensure efficient use of resources.

Lifecycle costs include both immediate and long-term costs. DoD Directive 5000.2 provides the following definition of lifecycle analysis for acquiring major weapons systems: to encompass everything from concept exploration through system retirement or demilitarization; it covers the entire service life of an item. Important elements in lifecycle analysis of SWM include procurement, handling, transport, storage, use, disposal, site remediation, and liability. Some important aspects of SWM, such as site remediation and liability, are not currently included in the Army's definition of lifecycle costs in the acquisition process. Although costs are difficult to estimate, the Army would benefit from estimating and considering them in the decision making process.

Lifecycle analysis calls for a thorough ("cradle-to-grave") assessment of costs, but not necessarily over the entire range of associated costs. The concept of full cost analysis provides a broad definition which captures all effects (costs) on both the Army and society. Full cost analysis would encompass indirect as well as direct costs of SWM, including the costs SWM imposes on society, and also the resources it diverts from other activities. The major components of full cost analysis include direct costs, deferred costs associated with liability, opportunity costs, externality costs.

Direct costs cover elements of SWM and disposal such as equipment, operation and maintenance, and personnel. SWM choices might involve actions for deferring liability for financial payments or cleanup. Opportunity costs are those associated with diverting resources, such as land or personnel, from alternative uses. Externalities are the indirect, unintended costs imposed on society, such as environment or property damage, risk to human health, and nuisances such as air pollution, noise and odor.

Estimating full costs would help assess the total implications of Army actions. Analyzing full costs can highlight efficient options when choosing among strategies and approaches. Full costs include societal or future costs as well as direct costs. Approaches can differ significantly in the magnitude and distribution of indirect costs.

Cost analysis also applies to prediction and measurement problems. For example, deferred liabilities for site remediation may not affect the Army until 30 or 40 years after a given decision. The analyst cannot predict all the ways current technologies may prove ineffective, or the future costs of addressing these problems.

Analysts may not be able to define objective and meaningful measures for all important elements. For example, precisely quantifying environmental quality will require subjective judgments that are difficult to compare with other types of cost estimates. Many analysts choose to assign monetary or numeric values to environmental quality as a standard of comparison. However, the accuracy of these valuations is impossible to verify. Ten analysts might assign very different values to the same environmental resource. While there is no perfect answer, the Army must attempt to consider externalized elements, such as the value of environmental quality. If the Army does not attempt to value environmental assets and societal costs, it effectively sets their value at zero. Including approximations of non-monetary values, though imperfect, is better than ignoring them. Only in this way can the Army minimize total societal costs.

Advantages and Disadvantages

Lifecycle and full cost analysis might uncover otherwise hidden environmental costs and savings. A drawback to cost analysis is that, because it includes environmental and societal costs that are particularly difficult to value, it may be far from precise. Also, completing this analysis may add considerable expense in the short run to the decision making process. The cost for conducting such an analysis includes the expense for data collection and tracking SWM expenditures. The person-hours needed to perform the analysis may initially be high because valuing the benefits and costs of each alternative can be difficult. However, the estimation process would become cheaper and easier as the process matures and the Army gains experience. Roughly estimating lifecycle and full costs would cost less in the long run than ignoring substantial (but hard to quantify) cost elements.

4.1.3 Decision Criteria for SWM

Decision criteria could aid in SWM decision making by defining principles, thresholds, or ratios to help ensure consistent policy implementation, cost effectiveness, or achieve certain environmental objectives. Decision criteria can be either required or used as guidance for making informed SWM decisions. Criteria often provide general guidance for decision making, but can also provide specific performance based criteria, such as minimizing the environmental risk of siting landfill near drinking water sources. Three types of SWM criteria the Army might use are:

- Environmental criteria to avoid or minimize human and ecological impacts
- Cost criteria to set cost cutoffs or ratios for program elements
- Policy criteria to help set limits or prioritize elements of solid waste decision making that will help implement Army solid waste policy.

Approach: Environmental Criteria

Environmental criteria could identify thresholds to minimize environmental impacts and to evaluate environmental trade-offs of SWM alternatives. Environmental criteria for facility siting, operation, and closure, for example, could be particularly useful in solid waste planning. These criteria could be established based on legal requirements and/or accepted management practices. General environmental criteria are possible, e.g., prohibiting the siting of a disposal facility where it might disrupt endangered species habitat. But environmental criteria are likely to be more technical compared to general policy criteria. For example, environmental criteria could prevent siting landfills where porous soils and high water tables exist in close proximity to drinking water sources.

Many environmental criteria already exist for landfills in the form of federal and state regulations. The October 1991 landfill criteria set minimum requirements for landfill siting, design, operation, closure, and post-closure. Appendix B provides an example of how environmental criteria could be developed for landfill siting based on these rules and accepted management criteria found in the literature. These criteria are not an exhaustive list, but provide an example. Installations would also have to evaluate local conditions and state regulations on siting to determine if more stringent criteria are appropriate.

Approach: Cost Criteria

The Army could also incorporate cost thresholds or ratios into SWM decision making, either to guide specific process/purchase choices, or to require and define elements for lifecycle analysis (see Section 4.1.2). Cost criteria might be required for SWM decisions, such as criteria to assess building a new solid waste facility compared to contracting private or municipal services, or what to evaluate in comparing resource and disposal costs to total costs and savings from recycling. That is, the Army could use cost criteria to define the economic feasibility for such various solid waste program elements as incinerators, landfills, and/or recycling programs. A percentage or ratio threshold allows consideration of local conditions, which are highly variable around the country, and facilitates attainment of policy objectives by setting guidelines for lifecycle cost-benefit analysis. An example of a cost-criteria for recycling would be to initiate a recycling program for an item if sales returns plus disposal savings are a given percentage of the collection and transportation costs.

Approach: Policy Criteria

Policy criteria could aid in ensuring consistent implementation of specific Army solid waste policies while allowing flexibility for site-specific conditions. Policy criteria could incorporate environmental and economic criteria, but would not be based solely on those considerations. Policy criteria might define the social, political, ethical, or management principles for SWM decisions. Policy criteria could provide feasibility thresholds (based on technical, managerial, political or cost considerations) for deciding procurement alternatives to reduce waste, whether to and what products to recycle, whether or what to compost, when or how to close a landfill, and, site and design parameters for incinerators and landfills. States such as Wisconsin and Washington have developed SWM criteria to help ensure consistent implementation of SWM policies. An example of a simple policy criterion would be to require all installations to recycle certain waste stream items if there is a regional market. An example that incorporates both cost and environmental criteria for implementing Army policy to discourage new Army owned and operated landfills, is to use municipal landfills when, the costs of that system are less than 125 percent of building and operating an Army facility, there is at least 10 years of remaining capacity, and there are no significant environmental compliance violations.

Advantages and Disadvantages

The advantage of establishing SWM criteria is to ensure effective installation SWM by providing specific requirements and/or guidance for installation solid waste decision making. Establishing such criteria should result in greater consistency across Army SWM programs, but also allow flexibility to accommodate important differences, such as recycling markets, regulations, and environmental conditions. Policy-makers would have to ensure that centralized criteria did not constrain installations from addressing site-specific issues. Because environmental criteria are often more specific, there must be particular caution that they provide adequate consideration of local conditions. Therefore, it would be advisable to state specific criteria (e.g., do not locate landfill within 400 meters of a perennial river) as planning guidance and not as stringent requirements. SWM criteria should encourage installations to make better informed decisions based on site-specific conditions. Another concern over establishing criteria is that technology, natural conditions, and regulatory requirements evolve and require constant monitoring. Therefore, criteria and indicators should be reviewed periodically to ensure their relevance and accuracy.

Developing and implementing SWM decision criteria would entail some cost. Further technical guidance would be needed to implement useful environmental, cost, and policy criteria. The long-term benefits should outweigh the short-term costs by ensuring more efficient, cost-effective SWM. After developing SWM criteria, a second more costly step would be to develop a decision making process using the criteria. USACERL received FY92 funds to develop a computerized system for SWM that might provide a framework for integrating solid waste criteria into a systematic decision making process. This project could potentially provide a vehicle for integrating SWM decision criteria at the installation level.

4.2 Waste Prevention Tools

4.2.1 Source Reduction

SWM programs which focus on reducing waste generation and toxicity rather than on waste disposal have great potential for increasing efficiency. This front-end approach aims to eliminate excess waste, and is the highest priority in EPA's pollution prevention hierarchy.

Approaches

Source reduction strategies prescribe actions that reduce total volume, weight, or toxicity of waste materials. Waste volume and weight can be reduced by manufacturing products which use fewer materials, including packaging, and are durable, reusable, and minimally bulky. This might involve modifying or substituting the raw materials used for the manufacturing process. Because the waste created from operating equipment can be substantial, it is important to design or purchase facility equipment, tools, and procedures which create minimal waste by-products.

Waste content can be improved by reducing toxicity of product materials and of waste by-products. Reducing toxicity involves identifying toxic substances and finding more benign substances or technology changes to perform the same functions. Some substitutions are non-controversial, such as replacing solvent-based cleaners with water-based ones. Frequently, however, there are difficulties in determining what is safe. Substituting new materials may remove one danger, but pose other dangers that are as yet unknown. Finding safer substitutes is an area that needs further development and will require a great deal more data.

Another approach to source reduction is increasing reusability, recyclability and biodegradability of product and waste by-product materials. Increasing substitution of plastic for glass and other heavier materials presents problems of non-degradability and less reusability and recyclability, as well as contributing to dioxin emissions in incinerators, use of non-renewable resources, and the production of substantial quantities of hazardous wastes during manufacture. Some benefits of plastic packaging include reducing the quantity of waste in terms of weight, the energy required for transport, and the amount of food spoilage. If landfill technology moves toward increasing biological degradation to prolong capacity, lack of degradability might be a problem.

The Army can reduce waste through improving product and packaging design. It could revise mill specifications and procurement criteria to promote use of "green" materials and accommodate product substitution. The Army manufactures (or contracts suppliers to produce) military–unique goods and services, including the design and procurement of weapons and other materials. Product design standards normally consider only initial costs, and fail to include the full (lifecycle) costs of creating and using the product. If full costs were factored into product evaluation, the Army would minimize material used to produce and package these goods, increase their durability, and use environmentally safer materials.

In addition to product and packaging design, the Army can influence what it procures from non-military suppliers. The Army is a large and powerful consumer—DoD commissaries make up the fifth largest retailer in the United States. The Army might restrict or ban toxic materials or products, and provide procurement incentives to installations or units for buying less toxic, less wasteful items. The Army can also influence its employees' personal purchases through awareness programs. Finally, the Army can design facility operations and maintenance processes to create fewer waste by-products.

At the installation level, the Army could also require reduction plans together with periodic reporting, or charge units or installations by waste volume. On the other hand, the Army might play more of an assistance role by giving guidance, setting targets, facilitating information and technology transfer, providing monetary rewards for waste reduction efforts, or temporary exemptions from existing rules to encourage innovative approaches. Each facility should analyze its own waste streams to determine the best targets for waste reduction. This is particularly important when complex trade-offs are involved; a full cost analysis is needed to inform decision-makers of optimal reductions in such cases.

Advantages and Disadvantages

Source reduction lessens Army waste impact on the environment, provides an opportunity to demonstrate Army leadership, extends the life of landfills, and reduces the need to incinerate or recycle. Using less toxic products would help lower risks to human health and the environment, and reduce liability and cleanup costs from future environmental damage.

The cost of initiating source reduction can be notable. Product, packaging, and manufacturing process changes might require large investments. Less toxic substitutes for raw materials may cost more than their alternatives. However, source reduction might save the Army money in the long run in addition to increasing environmental protection. Savings might result from less and safer waste to collect, transport, and dispose, and by using more durable goods.

In addition to short-term costs, disadvantages to source reduction arise when changes in the manufacturing process or the reformulation of products or packaging diminish the product's quality or effectiveness. Packaging, for example, plays a key role in protecting products, promoting safety, and minimizing theft, as well as in advertising. The Army, like the nation, often lacks sufficient information about its wastes and available reduction techniques. Further, environmental laws and regulations encourage an end-of-pipe treatment approach over waste reduction or substituting less toxic materials. Commanders understandably give higher priority to meeting existing requirements than trying innovative approaches or going beyond compliance.

Trends

While identifying and quantifying source reduction within industry is difficult, it is easy to see that this strategy is increasing in popularity. Corporate reduction examples include reduced packaging, greater use of water-based solvents, and redesigned batteries to eliminate mercury. Food packaging manufacturers have also made waste minimization efforts by redesigning soft drink cans, cooking oil bottles, and ice cream cartons. Paint industry manufacturers have replaced lead in exterior house paints with titanium and zinc pigments (DoI, 1985). As SWM costs rise and technology improves, the Army will most likely pursue more source reduction strategies.

State and federal policies increasingly favor source reduction. The Pollution Prevention Act of 1990 promotes source reduction. The Source Reduction Council, established by the Coalition of Northeast Governors (CONEG includes PA, NY, NJ, CT, RI, NH, VE, ME, and MA) developed model legislation to ban lead, cadmium, mercury, and hexavalent chromium in packaging. Seven of the nine CONEG states as well as several other states have enacted the legislation. New York State is considering legislation to require standards of reusability and recyclability in packaging.

4.2.2 Procurement Policy

A substantial portion of the Army's solid waste is generated from items purchased through procurement channels. Procurement decisions, therefore, are an important tool for improved SWM. By including SWM costs and potential liabilities associated with toxic materials in full cost accounting, and using this cost accounting as a basis for decision-makers, procurement can support integrated waste management.

Approaches

Procurement guidelines could be premised upon the objective of no net increase or some rate of decrease, on a per capita basis, or on the generation rates of a specified base year. These restrictions can require purchasing and producing:

- Items with no or minimal packaging
- Materials with no toxic agents (except when functionally necessary) that can create problems in disposal (land or incineration) or recycling systems

- Items packaged with consumable, returnable, or refillable reusable packaging
- Items packaged with recyclable material
- Recycled goods, such as recycled paper, re-refined lubricating oil, and retread tires
- Facility equipment which produces minimal toxicity and volume of waste by-products.

To promote integrated waste management, the military can also base its packaging specifications on performance. Specifications (written by DLA) sometimes create over-packaging, partially because they are not based on performance. They are based on specifications such as weight, materials, quantity per unit pack, and methods of preservation. These specifications are inefficient and often become quickly outdated. For example, a tin can may be required to be a certain weight; now that other, lighter materials can preserve and protect an item just as effectively, this specification requires unnecessary additional weight. Basing specifications on performance introduces flexibility in packaging that would increase efficiency. A performance basis would enable the military to utilize new packaging and shipping technologies, and new materials.

Performance-based specifications should consider protection, utility, and communication. Packaging protection standards determine the loss and damage costs of an item. Packaging utility standards determine the convenience of use, and the transportation, storage, handling, and warehousing costs of an item. Packaging communication (package marking) standards influence the costs of sorting, delivery time, mishandling damage, and accounting.

Few federal agencies have affirmative procurement programs; many deny they are responsible for purchasing environmentally sound products (BPI, 1991). Government procurement programs, which are intended to increase the demand for recycled materials, have not achieved the intended goal. According to a survey conducted by the Senate Subcommittee on Oversight of Government Management, no federal agency, except for the General Services Administration (GSA) and the EPA, meets the legally required affirmative procurement guidelines (Combs, 1991).

Advantages and Disadvantages

Waste streams can be substantially influenced by procurement guidelines. An improved procurement policy can help reduce waste toxicity and volume, and increase the amount of recycling. This might decrease required treatment of toxic materials and the need for future cleanup of disposal sites. As a major purchaser, the Army might increase demand for recycled materials. Positive publicity might result from improving procurement policy. The Army could set an example that may even influence other organizations.

However, procurement guidelines could add to production costs by requiring the use of more expensive materials. Also, the Army may not always be able to follow guidelines; the supply of recycled materials needed might not always be available. Procurement specialists would have to take great care that pollution prevention practices would not decrease product effectiveness. Performance-based guidelines should guarantee that efficiency/effectiveness would not suffer.

4.2.3 Incentives

Incentive strategies can help the Army increase source reduction and recycling, and reduce SWM costs. The Army should encourage employees to use recycled, recyclable, reusable, more durable, less toxic, less bulky items. Incentives can be positive (rewards for achieving an objective) or negative (punishment for not adhering to requirements). People are motivated by several factors, including money, awareness, recognition, a sense of obligation, and convenience.

Approaches

Everyone has the power to reduce and recycle to some extent. In the Army, groups to target are employees involved in the design and production of Army products, procurement employees, installation residents, line managers and installation commanders. For targeted personnel, the Army should provide education/training, and also incorporate objectives for integrated SWM (including use of lifecycle analysis).

Employees involved in product and/or process design can influence waste generated from operating, maintaining, and disposing of these products. Some potential financial incentives include basing capital investment decisions on full cost (including lifecycle environmental costs) to encourage upgrading of facilities, dedicating funds for source reduction procedures and using secondary materials, and discouraging use of specific products or materials through surcharges. The Army should educate employees to reduce production costs, waste by-products from operating and maintaining the equipment, and compliance costs with environmental and safety regulations.

Encouraging product and process design employees to use different materials (e.g., less toxic, more secondary) might require increasing the supply of these materials, which in turn requires better recyclable collection and processing procedures. Also, manufacturers will more readily use desirable materials if the manufacturing technology can process them cost effectively.

Another key group is procurement employees. Through purchase decisions, they influence what the Army consumes and eventually disposes. Procurement employees must be educated to include waste reduction and resource recovery in their selection criteria (see Section 4.2.2). Procurement employees will need to keep up-to-date on processes and technologies, and make judgments based on lifetime (lifecycle) cost. Incentives for contractors include basing procurement decisions on minimum full costs, permitting contractors to share in cost savings, and considering product standards such as product lifetime warranties.

Installation personnel have great potential for promoting pollution prevention. Convenience is one incentive. For example, curbside collection of recyclables increases participation. To increase awareness, the Army could mandate disclosure of environmental impacts on commissary product labels (such as toxicity, the amount of packaging, what is recycled and recyclable, where to take materials to be recycled) and could train employees to consider the cost savings from purchasing more durable products and bulk items. The Army might educate commanders about the reduction in liability and in risk to human health and the environment from sound waste management.

A negative financial incentive is to require residents to pay directly for waste management, through volume or weight-based pricing. Charging methods include simple individual charges by volume and/or weight, or charges at the time of purchase through bar-coding the retail items. Positive financial incentives for commanders and personnel could include passing on disposal savings from source reduction and resource recovery to the installations, or earmarking funds for commanders to create incentives for employees to source reduce and recycle. The Army would have to carefully consider the size of the incentive. Large rewards/punishments influence behavior more than small rewards/punishments, but incentives must appear to be fair and program costs must be reasonable.

Advantages and Disadvantages

Motivating employees is critical to achieving Army SWM objectives. Reducing waste saves the Army expenses for waste management. They would also decrease maintenance and replacement expenditures, because employees would be motivated to purchase and use more durable, reusable products.

The cost of implementing new incentive systems can be substantial, because there are few incentives to source reduce and recycle in place currently. Also, it may be difficult to monitor individuals and processes, and to identify waste reduction. Large incentives might encourage unintended results and cheating. For instance, to avoid large disposal charges, people may attempt to find illegal, unsafe, or unsound ways to dispose of their waste. Large fines or punishments can cause resentment. Expansive restrictions might decrease efficiency and eliminate cheaper raw material options. The decision-maker should consider the trade-offs between effectiveness, and costs of various incentive types and magnitudes.

4.3 Waste Handling Tools

4.3.1 Recycling

A recycling program is one tool that can be used in an overall SWM plan. Any recycling program will need to determine markets, and collect, process, and transport materials. Most current recycling programs process one or more of the following items: glass, aluminum, paper (newspaper and mixed), cardboard, steel, and plastic. On Army installations, brass and other scrap metals are also significant items for recycling.

Recycling programs can be relatively inexpensive or quite cost intensive, depending on the program. Cost variables include the scope of the program, types of containers and vehicles, education requirements, facility requirements, and efficiency.

Revenues can also vary depending on the program. Fort Lewis estimates that their 1991 total operating costs were approximately $274,000 and total revenue was approximately $321,000 (Wofford, 1991). Fort Riley estimates their total revenues at between $300,000 and $400,000 per year, including both materials marketed by the installations and those marketed through DRMO (Ness, 1991). Overall, for only those materials marketed through DRMO, the Army reported revenues of more than $12 million in 1991.

Approach: Marketing

Finding markets and determining market demand for recyclables are essential to creating a successful program and will require a great deal of research and effort. Three major marketing options are to:

- Sell directly to market, e.g., Alcoa buys aluminum
- Use a broker, e.g., material recovery facility or intermediate processing center
- Contract a full service vendor to collect, process, and market recyclables.

Each option has advantages and disadvantages. For example, selling directly to a buyer avoids any middle man and may mean more profit for the recycler, but gives the recycler the sole responsibility for finding and maintaining markets. Generally, the market will only accept materials that meet certain standards, which may vary from buyer to buyer. For example, a paper buyer may require that the paper be shredded and baled. An installation with the capabilities to process the materials may want to market directly. Without processing capabilities, the installation would either have to find a buyer that doesn't require any processing, or would have to go through a broker or a contractor. A full service vendor would minimize complexities, but could add considerably to program costs. As discussed in Chapter 3, marketing can be restricted by requirements to use DRMO.

Approach: Collecting

Three general approaches for collecting materials in a recycling program are drop-off centers, buy-back centers, and curbside pickup.

At a drop-off center, participants bring their recyclables to a site, and the recycling agent picks them up for processing and/or marketing. A buy-back program pays participants for the recyclables they bring to a given location. With curbside pickup, participants leave recyclables on their curb for a collection vehicle to retrieve. A program may include one, two, or all three methods. Drop-off sites are most economical for the recycling agent, while buy-back programs provide an economic incentive to participants. Curbside pickup is the most convenient for the participant, but the most expensive option for the recycling agent.

Approach: Processing

Several approaches available for processing materials are:

- Commingled—separating waste into two or three major categories, generally, recyclables and non-recyclables
- Source separated—further separating waste by dividing the recyclables into several containers.
- Mixed waste—no separation, all solid waste is in a single container

Generally, materials pass through some type of processing facility. Material Recovery Facilities (MRF) and Intermediate Processing Centers (IPC) prepare recyclable materials for the marketplace. An IPC often handles only source separated materials, while an MRF is generally a larger facility that may handle mixed waste

(Radke, 1991). Recycling programs may need to store materials before processing and/or being taken to market. An MRF or an IPC can serve this purpose. If there is no storage capacity, then the program should be designed with little or no delay between collection, processing, and marketing.

The processing method depends upon the recycling program. Most municipal recycling programs separate recyclables from other garbage. The recyclables are either commingled or source separated. Both methods have advantages and disadvantages. Commingled is more labor intensive for the hauler and processor because eventually all recyclables must be separated. Source separation requires more complex vehicles and storage areas to keep each item separate (Bell, 1989). Another processing option is to pull recyclables directly from the waste stream. This mixed waste processing method had limited success in the 1970s, but has seen a recent resurgence of popularity. Mixed waste processing is either manual, mechanical, or some combination of both.

Manual processing usually focuses on one item that can easily be picked from commercial waste streams, such as corrugated cardboard. The remaining waste could either be processed further, or sent to an incinerator or landfill. Mechanical processes have a high capture rate for metals and provide substantial landfill diversion. They are, however, quite costly, maintenance intensive, have a record of safety problems and often produce poor quality end products. The majority of mixed waste processors use a combination of the manual and mechanical methods. These systems usually obtain higher recycling rates than either of the components, and almost the same landfill diversion rate as mechanical systems, all at a much lower cost (Apotheker, 1990). Source separated systems often use manual and mechanical processing as well. The difference is that there are only recyclable materials in a source separated system. They generally have fewer maintenance and safety problems, and provide high quality recyclables that command a better price in the marketplace (Sweeney, 1989).

When deciding which collection and processing methods to use, planners and managers should consider: 1) the time and costs required to collect and, if necessary, separate the materials; 2) the convenience of the collection method, and 3) the equipment and manpower needed to collect, transport, and process the materials.

Processing options, collection methods and marketing requirements are all closely linked. For example, if the program uses a process requiring source separated materials, then the collection method must be able to accommodate the different materials and keep them separated. If the market requires that all cans be crushed and baled, then the processing center must be equipped to do this.

Approach: Composting

Composting programs require many of the same things as a recycling program. There is a need to collect, store, treat, and either use or compost market materials.

Many composting programs handle only yard wastes. In many cases, these wastes have been banned from the landfill, and composting provides a viable alternative. Composting reduces the volume of waste and creates a product that can be marketed to landscapers, homeowners, farmers and anyone else who may have a need for rich, organic material. Some facilities compost materials to use for required landfill cover, which saves cover costs and landfill space, in addition to revenue from fees for composting.

Recently, there have been a number of programs developed to compost mixed waste. These facilities are often run in conjunction with a recycling program. In some cases, recyclables are removed at the composting facility. Some programs screen the waste prior to composting for non-compostable materials; other programs screen the final product to remove uncomposted material.

Issues involved with composting programs include odors, leachate and pathogens, plants and fungi. Odors occur when the biological process is allowed to become anaerobic. Controlling temperature and moisture content can reduce this problem. Leachate is created when the moisture content is too high. The concern with leachate is that it may contain heavy metals which could leach into the ground. Creating a product with heavy metal concentrations also limits the marketing potential for the compost. Pathogens, plants and fungi can severely affect the quality of the final product and can pose health threats to workers.

Composting costs vary greatly depending on the sophistication and scale of the program and the quality of the product is crucial to marketing the compost successfully. States have different standards for how compost can be used, and what determines the quality of the compost. Further, compost markets are not well developed, and shipping is expensive because of its weight (Hairston, 1992).

Advantages and Disadvantages

A significant advantage of a recycling/composting program is that it can be a profit-making venture. At the very least, it can avoid costs by reducing the amount of material being disposed. It might provide an opportunity to cooperate with a local community. This can help the installation meet its program goals and provide a valuable public relations tool. As an environmental benefit, recycling often saves natural resources and energy, and reduces pollution. For example, recycling aluminum reduces energy use by 90 to 97 percent, air pollution 95 percent, and water pollution 97 percent compared to using virgin resources (Pollack, 1987). Based on these varied benefits, it may be desirable to operate recycling programs even if they do not generate revenue.

Disadvantages of recycling are that markets for recyclable materials change constantly and dramatically. Some large categories, like plastic, do not have well-established processes or markets. Many recycling programs are heavily subsidized and do not make a profit. Recycling programs often create increased truck traffic, noise, smell and litter. Establishing and maintaining a recycling program can be a labor-intensive project. Under current operating procedures, the requirement to use DRMO is sometimes a disadvantage due to inefficiencies and lower prices for materials. Additionally, installation programs are not generally subsidized and are not permitted to include cost avoidance when calculating their success, and therefore do not show a profit on many materials. Profits are not the only benefit and should not be the sole criterion for recycling decisions.

Composting programs can greatly reduce the volume of waste requiring disposal, save landfill cover costs, and sometimes produce income through composting fees. Low-tech programs can be quite inexpensive and contribute to waste reduction efforts. Disadvantages include costs for high-tech programs, plus the management requirements to avoid odors, leachate and pathogen problems.

4.3.2 Incineration

Incineration can reduce the volume of MSW ultimately landfilled by as much as 90 percent (Zykan, 1988). Reduction in weight is less, usually about 70 to 75 percent (Environmental Defense Fund, 1986; OTA, 1989). The Army has faced operational, environmental, and economic problems with its existing MSW incinerators. In fact, only three of its seven incinerators are still operational. The Army placed a moratorium on the construction of additional heat recovery incinerators (HRI) in the late 1980s, pending the formulation of a functional standard design to overcome the problems of the previous plants. A standard design was prepared by USACERL in 1989. USACERL has been working on waste-to-energy research since 1973, and has developed recommendations for planning and operating small incinerators (Salimando, 1987). These recommendations provide guidance on conducting waste surveys, determining the feasibility of an incinerator, design of facility, contractor support, and operator training. Some private sector experts note that public fears and economic conditions have stifled expansion of waste-to-energy incinerators for many years to come (Hairston, 1992).

There are a variety of different types of incinerators in the United States. The most common type of incinerator is a mass burn facility designed to burn 100 to 3,000 tons per day (tpd) of MSW with virtually no processing. Modular incinerators are usually smaller-scale facilities with a capacity range of 15 to 400 tpd that also burn unprocessed waste. Refuse-derived fuel (RDF) incinerators typically burn a shredded waste from which heavier, noncombustible items such as glass and metal have been removed.

Other less commonly used incinerators burn a waste stream that has undergone at least some preprocessing and can be burned with other waste such as sewage sludge. Another application of RDF is to burn it with coal. Most incinerator facilities have a heat recovery system that captures the heat released during combustion and converts it into steam or electricity, which may be used to generate revenues.

To operate successfully, an incinerator must be part of an integrated solid waste program. An installation should first try to maximize source reduction and recycling, and then evaluate the need for an incinerator. The minimum and maximum capacity of an incinerator should be designed for the remaining waste flow after source reduction and recycling. A USACERL draft technical report concluded that 12 of the 48 installations evaluated in a 1991 study may benefit from integrating HRI into their waste management program. Seven of these installations have disposal needs that must be addressed within the next five years because of limited landfill capacity.

The Deputy Assistant Secretary of Defense (DASD) issued a memo on 23 July 1991 on waste-to-energy projects to provide guidance on planning, operations, financial management, and public affairs for waste-to-energy projects. Both the USACERL study and the DASD memo provide useful guidance on planning and operating MSW incinerators (Morales, 1991).

As landfill costs increase, incinerators will become more economically viable. A USACERL study on Army incinerators has determined that, to break even with operating and maintenance costs, more than 2000 tons must be processed annually for a single–unit, small–scale plant and 10,000 tons for multi-unit systems (Salimando, 1987). Construction costs for small scale incinerators can vary from $1.6 million to $9.8 million for a 2412 tons per year (tpy) to a 35,000 tpy plant respectively. Annual operating costs can vary from $89,300 to $1.7 million for a 2412 tpy to a 35,000 tpy plant, respectively. Operation and maintenance (O&M) costs can be offset by as much as $398,000 per year for a 125 tpd plant, if the facility operates as planned (see Appendix C for more details).

The O&M figures in Appendix C do not reflect the cost of ash disposal, which varies widely around the country and can be significant. If ash cannot be disposed of in local MSW landfills due to state laws, additional costs will be incurred. For example, Fort Lewis is required by the state of Washington to build a five acre monofill for its incinerator that will cost $2.8 million.

Ash disposal costs can be minimized by removing non-combustible materials (e.g., metals, aluminum, and glass) before incineration. Recycling non-combustible materials can improve the overall energy efficiency of the facility, resulting in a 35 percent reduction in the amount of waste burned and reduce construction costs by 16 percent by reducing the boiler size (Shortsleeve, 1990). Finally, integrating recycling with an incinerator can reduce ash volume by as much as 39 percent, in addition to reducing toxicity.

The Institute for Local Self Reliance estimates that the cost of processing one ton of municipal waste per day by incineration ranges from $100,000 to $150,000, while the same amount of waste can be processed by composting for $15,000 to $20,000, by recycling for $10,000 to $15,000 (Global Tomorrow Coalition, 1990). However, with current technology, MSW that cannot be filtered out of the waste stream will still have to be disposed of in incinerators and landfills.

Advantages and Disadvantages

The environmental and economic feasibility of incinerators depends on the site–specific characteristics of the facility and the servicing area. Harmful air emissions (e.g., dioxin, furan, sulfur dioxide, nitrogen oxide, carbon dioxide, and heavy metals) are generally the primary environmental concern of incinerators. If not removed from incinerator effluent, acid gases can cause respiratory disease, harm plants, corrode metals, and contribute to acid rain. Incinerator lead and mercury emissions can cause neurological disorders, and cadmium and arsenic may cause cancer (Global Tomorrow Coalition, 1990).

Incineration produces residual ash that is approximately 25 to 30 percent of the total waste burned by weight. According to tests conducted by the Environmental Defense Fund, 90 percent of samples exceeded limits for lead and cadmium. Toxics present in the ash might enter the water supply via leachate in landfills. In addition, release of ash into the air during transport and handling can affect human health through inhalation, dermal contact, and contamination of food and soil.

By using the best available control technology (BACT), incinerator air emission can fully comply with new CAA requirements. BACT for controlling incinerator air emissions includes maintaining high heat levels to remove many toxic materials, using scrubbers to reduce acidic gases by adding alkaline reagents that react with the gases, using electrostatic precipitators that remove particulates, and by using baghouses that use an array of cylindrical bags that filter flue gases. Even hazardous ash from incinerators can be mitigated by removing metals before combustion. MSW incinerators have been integrated into cement works in Europe where waste is burnt in the cement kilns and the remaining ash is incorporated into the cement. This process effectively immobilizes the hazardous heavy metals (Holmes, 1981).

Another significant environmental consideration mentioned previously is that incinerator operation could be a negative incentive to source reduction and recycling programs because incinerators require certain minimum quantities of waste that have a sufficient Btu value. Preventing high Btu components, such as cardboard, paper, and plastics, from entering the incinerator stream could make an incinerator economically infeasible. Effective incineration and source reduction/recycling programs can coexist if decision-makers have reliable data on waste generation and characteristics. Incinerators can be designed to handle the waste stream volume, based on adjustments for source reduction and recycling.

4.3.3 Landfilling

Landfills are the most common resting place for solid waste because they are still relatively cheap. The national average for tipping fees was $26.93 per ton in 1989 (Pettit, 1989), but costs vary considerably by region, and fees have been rising in all regions of the United States (NSWMA, 1991). In mid-1992, for example, costs varied from $10 per ton in San Jose, California to $131 per ton in Morris County, New Jersey (Bailey, 1992). Landfills are often underpriced because tipping fees are established without considering such costs as the depletion of older sites, opportunity costs of land being used, environmental risks, closure and post-closure costs, or liability costs. Some locations pay inflated fees due to competition or poor contracts. The major issues facing a landfill planner and/or operator are siting and complying with federal, state, and local regulations on operating/managing and closure/post closure (Berkman, 1987). The additional landfill requirements EPA issued in 1991 significantly affect landfill management, by increasing costs of building, operating, and closing these facilities.

Approach: Siting

Siting landfills in the private sector has become increasingly difficult. The problem is not always a lack of land. Throughout much of the midwest and the west, land is still relatively plentiful and cheap, but public opposition (the NIMBY syndrome) makes siting difficult in many regions. A 1989 survey found that 65 percent of the general public oppose building a new landfill (Wasserstrom, 1989). Army installations have not experienced problems with NIMBY because installation commanders have the authority to site a landfill on post (Bauer, 1991). The installation must, however, meet any state and local requirements concerning siting and permitting a landfill.

In some areas finding land with the appropriate physical characteristics (e.g., water table level, soil composition, moisture) to support a landfill is a critical problem. In heavily populated parts of the country such as the northeast, finding enough acreage can be a problem. Increasing legal requirements for the siting and permitting process at the state level contribute to the difficulty in finding locations for new facilities. Some Army installations have appropriate sites. When this is the case, the installation should consider siting a new landfill on post when selecting solid waste disposal options.

Another common issue in landfill siting is interstate transport. Some areas do not want to accept garbage from their neighbors, while other areas willingly accept it at the right price. Costs are a final concern in siting a landfill. Landfills are becoming significantly more expensive not only to site, construct and operate, but also to close and maintain for many years afterward. As regulations require more testing, monitoring and control, costs are increasing.

Approach: Operating/Managing

Legislation varies from state to state concerning the permitting, design, inspection, leachate, and methane controls for landfills. Managing leachate from a landfill is important. The leachate can contaminate groundwater and, if hazardous and toxic wastes are present in the leachate, can create serious and long lasting environmental problems. Contaminated groundwater might pose exposure problems for people and crops, and also threaten plant and animal life. Once groundwater is contaminated, cleaning it up is a slow, costly process.

Biodegrading organic matter in a landfill produces significant quantities of methane. Controlling this gas is important because it can migrate underground and cause explosions miles away from the original landfill. Some landfills utilize a process which captures the methane, and use it as an energy source.

Many people have the misperception that anything biodegradable will disappear in a landfill. In humid, wet states like Florida, this is often true, but it is not true for many other areas of the country. Modern landfill technology (and regulations) calls for covering landfills each day, creating a dry, airless environment which is not conducive to biodegradation. Recent research at landfills has uncovered 12-year-old newspapers that can still be read, a 15-year-old steak and a 20-year-old ear of corn still intact (Rathje, 1991). Increasing biodegradation may not be desirable. If there are contaminants in the fill, a dry environment is best to avoid leaching.

Approach: Closure-Post Closure

The EPA Subtitle D regulations, issued in October 1991, establish more stringent maintenance and monitoring requirements to be maintained for years after closure. States may impose even stricter technical standards. A large factor in closure and post-closure are the costs. One study estimated that a simple closure in 1990 cost approximately $13,000 per acre, compared to perhaps $25,000 to $50,000 per acre with the more comprehensive and stringent closure and post-closure requirements (Gleb, 1990).

Advantages and Disadvantages

The biggest advantage of a landfill is cost; it is currently the most economical method for disposal in most parts of the nation. Costs, however, can vary tremendously. New facilities can become quite expensive, depending on such factors as the level of NIMBY activity, state requirements for leachate control and monitoring equipment, liners, daily cover needs, liability coverage, and labor and equipment. Aside from increasing legislative requirements and consequent costs, disadvantages are that landfills (especially older ones) might pose a threat to the environment through leachate, litter, rodents, and other pests. Public opinion and NIMBY reactions in some regions make it difficult to construct new landfills.

There are, however, numerous technologies being developed to make landfills environmentally safer, including better liners, leachate control systems and efforts to mine landfills to remove items that may cause contamination and extend the useful life of the landfill.

4.4 Implementation Tools

4.4.1 Regionalization

Army Regulation (200-1, Section 6-2 a. [3]) "encourages the use of joint or regional resource recovery or waste treatment facilities with federal and nonfederal agencies (including commercial waste treatment facilities) when advantageous, cost effective or more efficient to the Army." As discussed earlier (Section 3.5.3), current Army policy requires HQDA approval before siting such facilities on Army property. A policy memo by the ACE dated 5 September 1991 states that undefined environmental standards, increased costs to meet new standards, plant complexity, and operator certification and availability, may make it advantageous for the Army to use municipal, regional, and cooperative systems for utilities. This guidance indicates that the Army will increase its use of regional landfills and incinerators instead of building new facilities.

The Army may want to consider creating true regional agreements for establishing recycling processing centers, landfills, and incinerators, rather than simple contractual arrangements in a region. AR 200-1 uses the term "regional" to imply using a non-Army facility. In general, a regional facility results from an agreement between partners to site, construct, operate, and use a facility. Regionalization could also include solid waste planning efforts between partners. The Army may want to look at genuine regional planning opportunities as well as simply using an existing facility and paying for the service.

Potential partners for establishing truly regional facilities include other nearby military installations, private industry, and municipalities. As the Army scales down, leaving installations with fewer people qualified to handle solid waste issues, regional planning and/or facilities may provide a solution. The Army may also be in a unique position to help alleviate siting problems among partners by providing land for facilities. The waste–to–energy plants at APG, Maryland, and Redstone Arsenal, Alabama, are examples of such an agreement (Section 3.5.3).

Another option is to have the Army provide solid waste facilities to serve a region. Participants at AEPI's 1991 Solid Waste Policy Workshop suggested that as the Army downsizes and creates fewer, larger installations in remote areas, there will be no local infrastructure to support the installation. Such installations will create facilities for their own needs that could also service surrounding communities, with the Army operating facilities and charging others for their use. Another possibility is for the Army to own, but a contractor to run (a GOCO) a solid waste facility, charging others for its use. Yet another option is for the Army to donate land, buildings or other resources to a city or contractor to establish solid waste facilities that the Army could use.

Advantages and Disadvantages

In areas with a well-developed infrastructure, it may be more efficient and cost-effective to use an existing program or join existing regional agreements. The advantage could be having the experienced available staff of the municipality or private entity operating a facility, rather than duplicating solid waste systems, especially where trained Army personnel are not available. Establishing regional landfills, incinerators, recycling programs or other facilities takes advantage of economies of scale—it is more economically feasible to have one large facility than several small ones. For recycling centers, this is especially relevant for developing markets. The larger group may be able to secure more and better markets than several smaller operations.

Larger, shared facilities may also help alleviate some environmental concerns. Assuming the facilities are constructed and operated properly, there might be fewer risks of environmental problems simply because there is only one facility. Such facilities might pool resources to allow for more stringent oversight including control over what types of materials enter the facility.

The Army could benefit economically and from developing positive public relations by establishing Army-owned regional facilities where no facilities exist. These areas may not have the population base or industry interest for establishing full regional agreements. An installation commander could site a landfill on post, subject only to the permit process and other state or local requirements. The Army could also provide the organizational, planning and administrative know-how to site, build and perhaps operate the facility.

Disadvantages may include strains on manpower, the difficulty of establishing adequate liability protection against non-Army waste streams, and the challenge of integrating the role of solid waste businessman into the Army's military mission. Specific limitations include that recycling agreements may not be appropriate or possible for all items, if materials must be processed through DRMO.

4.4.2 Awareness, Training, and Education

Any solid waste program requires awareness, training and education. Awareness is defined as informal programs to disseminate information to a wide variety of people. Training implies job specific courses or information provided to enable employees to perform their duties as effectively as possible. Education is a formal program, usually resulting in earning a certificate or a degree.

Approach: Awareness

Awareness can determine whether a SWM program succeeds or fails. People must be motivated to change their behavior to meet program goals. For example, if the program is attempting to reduce the waste stream by a certain percent, people must be told how they can reduce their personal waste stream and contribute to the overall reduction effort. With mandatory requirements, people must be told what the regulations demand. General awareness is a necessity for running successful reduction and recycling programs.

Participants must learn how their solid waste program is designed so that they can become fully involved. If there is a recycling program, participants must know what types of materials are accepted and where they are accepted. People must be properly motivated to do whatever the program requires. Convenience provides an incentive to participate. Common sense indicates that the more convenient the program, the higher the participation. Convenience, however, must be weighed against the cost and time involved for other aspects of the program. Public awareness programs can often make a less convenient program just as successful.

On an Army installation, developing public awareness strategies is crucial because of the transient nature of the populace. As people move from installation to installation, they must be able to become familiar with the SWM program quickly so that they can participate effectively. Public awareness should begin long before the program is actually in place. The Installation Recycling Guide provides suggestions for creating a good public awareness campaign (EHSC, 1991). Possibilities include utilizing a base newsletter or paper, establishing programs at grade schools, and speaking at wives' club meetings or other on-post organization meetings.

Approach: Training

Another component is training personnel who manage solid waste issues on proper handling methods. Solid waste facilities and processes require technical skills and can require specialized professionals. Knowing how to operate equipment, handle certain wastes, and comply with regulations can all be part of the daily activities at a solid waste facility.

An essential element of effective solid waste programs is adequate training for those running the program, from managers to service personnel who handle materials. As the nation focuses greater attention on waste prevention, the Army should consider training needs for those (e.g., procurement personnel, weapons systems designers) whose decisions affect the solid waste stream.

Approach: Education

In siting, constructing, and often in operating and maintaining facilities, it is necessary to have professionals educated in various engineering and environmental fields to ensure a sound and safe facility. Integrated SWM planning involves complex systems; designing, managing, and evaluating these systems most efficiently requires a sophisticated understanding of technical, economic and social elements. The Army needs to recruit and retain key personnel with appropriate education.

Advantages and Disadvantages

The greatest advantage of using awareness, training and education as tools is that they can be relatively inexpensive and highly successful if they are incorporated into existing programs. There are obstacles and challenges to establishing good awareness and training programs. Some programs can be costly. Additionally, it takes creativity, time and effort to get the message out and to ensure that employees are equipped to do their jobs. Repetition is the key, and on Army installations, the transient nature of the populace makes this an even more demanding challenge. Successful awareness, training and education programs can realize savings in pollution prevention, in cleanup, and perhaps in liability for inadequate programs.

4.4.3 Clearinghouse

Informational clearinghouses could provide technical assistance, information, and points of contact for SWM issues. A clearinghouse can also help municipalities or other entities comply with solid waste policies and regulations. Within the Army context, a solid waste clearinghouse could answer technical questions, provide educational materials, provide a repository of installation SWM plans and initiatives, maintain a current database of Army research and technology, provide updates on key federal and state legislation, ensure clear information flow on solid waste issues throughout the Army chain of command, help avoid duplication of efforts, and provide a means of evaluating and gaining feedback on SWM programs.

Existing national and Army solid waste clearinghouses provide a variety of services ranging from technical assistance to more general questions on solid waste. Some clearinghouses are narrowly focused and provide very specific types of information, such as the marketing trends for recycled products within a specific region. Others provide a comprehensive clearinghouse service on all aspects of SWM. Solid waste clearinghouses have been established in several states (such as Pennsylvania, Washington, Vermont), by the EPA, and by private organizations to provide education, information, and technical assistance on SWM (Table 4-2). For example, Pennsylvania has a solid waste hotline to provide up-to-date information on recycling markets in the state. The hotline also provides guidance on

Table 4-2 Examples of Existing Clearinghouses

Type	Name	Phone
EPA	Pollution Prevention Clearinghouse	703-941-4452
EPA	Recycled Products Clearinghouse	703-750-1158
EPA	Solid Waste Information Clearinghouse	800-677-9424
State	Pennsylvania Recycling Hotline	800-346-4242
State	Washington Recycling Hotline	800-RECYCLE
Private	EDF/Ad Council	800-CALL-EDF
Private	American Public Works Association	312-667-2200
Army	THAMA Env. Response Line	800-872-3845
Army	FORSCOM Clearinghouse	404-669-5419

starting municipal recycling programs. Clearinghouses can also help municipalities comply with solid waste policies and regulations.

EPA has three clearinghouses: 1) the EPA Pollution Prevention Clearinghouse, which provides a database and a hotline to provide technical support and information on waste minimization; 2) the Recycled Products Information Clearinghouse, which provides current information on markets for recyclable materials; and 3) and the Solid Waste Informational Clearinghouse (SWICH). SWICH is a comprehensive clearinghouse service that provides research services, access to their extensive library, a telephone hotline, and a computerized bulletin board service. SWICH provides information on source reduction, recycling, composting, planning, education and training, public participation, solid waste bills and laws, waste combustion, collection, transfer stations, disposal, landfill gas, and special wastes.

Currently, no single agency is responsible for disseminating information within the Army on SWM. Improving SWM and communication of policies, regulations, and success stories within the Army requires a central office to provide current information and technical assistance on waste reduction, recycling, incineration, disposal, and integrated SWM. The office should also coordinate information exchange on all Army solid waste polices, programs, and research and data collection initiatives.

DoD operates a number of clearinghouses and information centers for organizing, analyzing, and archiving information on narrowly focused topics. Within the Army there are several clearinghouse services, but none dealing specifically or in depth with solid waste issues. USATHAMA provides the Army Environmental Information Response Line for installations and MACOMs with technical assistance and information on a variety of environmental areas, including solid waste. USATHAMA also has an environmental alert system to disseminate important environmentally related messages to the MACOMs and the installations.

HQFORSCOM has implemented a comprehensive informational clearinghouse to provide support on NOV compliance, NEPA analysis and documentation, hazardous waste management and SWM for FORSCOM installations. After several years of operation, HQFORSCOM has received favorable feedback from their installations that the clearinghouse provides timely and helpful advice on environmental problems, including SWM.

Several electronic networks currently exist that could provide information on solid waste. The Defense Environmental Electronic Bulletin Board System (DEEBBS) is intended to disseminate information on DoD environmental initiatives, which could include solid waste information. The Environmental Information Connection (EIC), part of the Environmental Technical Information System (ETIS), is another informational source. EIC provides a reference search service and could be used to obtain sources of information on SWM.

Advantages and Disadvantages

A clearinghouse would benefit the Army by meeting Army SWM needs for information and coordination. Because users often call a clearinghouse with an immediate problem, it is critical that clearinghouses can respond within the time constraints of users. It is useless to establish clearinghouses if they cannot adequately service the constituency's needs. Clearinghouses rely on constant updates and information from users; if responses are unreliable or inefficient, the user community will quickly abandon its support for the system. In addition to help in trouble-shooting problems, a clearinghouse might provide an excellent mechanism to disseminate general information to planners and managers quickly.

A disadvantage could be the cost and diversion of resources required, especially during a time of shrinking defense spending. Army personnel might use existing clearinghouses both within and outside the Army, but additional resources would be needed to augment current capabilities to handle Army unique information and coordination. USATHAMA currently has a system aimed to give some support to installations. Perhaps resources could be efficiently used by building on their capabilities. If there are multiple clearing-houses, the areas of competence and responsibility for each should be clearly defined. Only with adequate resources and support from the HQDA and users can a clearinghouse significantly aid installation SWM and ensure smooth information flow throughout the Army.

5. Frameworks For Policy

5.1 Overview

This section sets out a broad framework for policy choices by laying out alternatives along a centralized—decentralized continuum for Army solid waste policy. Before defining specific policy elements, Army policy-makers should decide to what extent policy needs to be uniform across installations. Army policy-makers will want to select a long-term strategy that balances the need for local flexibility with achieving a coherent and consistent policy. They should consider how much control or consistency the Army wants to impose from the center, and how much discretion properly belongs to installation commanders. This decision will help define the scope and detail of Army policy directives, and what combination of SWM tools to require or recommend. The broad policy direction discussed below applies to both municipal and non-municipal SWM. Army solid waste policy might:

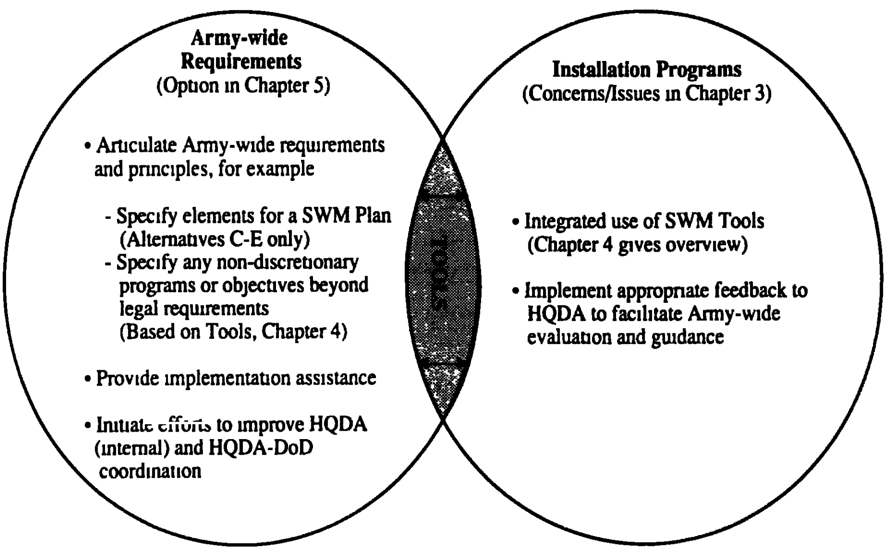
- Be left almost entirely up to individual installations to determine how to comply with federal and state laws
- Set Army-wide requirements to attain specified goals and objectives (taking into account installation diversity)
- Fall somewhere in between—for example, centralized requirements in only a few areas of SWM, or guidance on many issues but few requirements.

In general, a decentralized policy would leave most SWM decisions, beyond requirements imposed by federal and state laws, up to installation commanders. A centralized policy would set general criteria, and also specify outcomes or elements; as absolute requirements, as requirements if certain conditions are met, or as general requirements with exceptions possible. The more centralized the program, the more Army Headquarters would specify details about what should be achieved, or perhaps how to go about SWM. In either case, individual installation flexibility decreases as direction from, and accountability to, Headquarters increases.

Policy-makers can initiate action on some short-term solid waste issues and needs, whether SWM is centralized or decentralized. First, establishing a reliable baseline is essential to good policy making at the Army and installation levels. Whatever the overall long-term Army policy option chosen (with regard to centralization), gathering better data should be the initial step. Second, some solid waste program elements clearly need central, Army-wide attention, and cannot be effectively addressed at the installation level. Initiating action may not be dependent upon establishing baseline data. Efforts to: address Army procurement policies and specifications, establish one or more solid waste clearinghouses, assess incineration feasibility, and clarify Headquarters' roles and responsibilities regarding SWM (especially recycling) could be initiated immediately, and independent of the decisional framework below. In fact, addressing some of these issues, as discussed in Chapter 3, would require a decision at the DoD level, or perhaps Congressional action.

The link between Army issues and concerns, as outlined in Chapter 3, the available tools discussed in Chapter 4, and the Army-wide alternatives presented here in Chapter 5, is represented in Figure 5-1.

Figure 5-1 Concerns, Tools, and Alternatives



5.2 Decentralized<————>Centralized Policy

This paper presents a framework with several alternatives at varying levels of centralization along with examples. It does not attempt to present alternatives with specific components Army leadership might choose, as the possible combinations of SWM tools are too numerous, and sufficient data to support judgments about optimal use of these tools Army-wide do not yet exist. If Army leadership decides to adopt a somewhat centralized policy requiring more detailed assessment of some solid waste elements, the next step would be to identify the issues and costs for that level of centralization.

Starting with the most decentralized approach, the alternatives are to: contract out as much SWM as possible, endorse the status quo, create a minimum Army-wide SWM program, or create more centralized approaches (i.e. specify requirements). The purpose of this framework is to show the kinds of requirements, complexities and considerations involved in moving toward centralization. This discussion uses "criteria" to refer to general principles, and "requirements" to refer to more specific elements or procedures.

Each alternative is followed by a brief assessment of how it might promote or impede achieving certain objectives as defined briefly in Chapter 1. The importance of individual objectives will vary according to the situation and individual decision-makers will value them differently. The balance among objectives will also vary in different alternatives. In some cases pursuing one of them might be incompatible with pursuing others. Because this framework is at a high level of generality, and there is a lack of reliable data, these assessments are necessarily qualitative. The assessments are not meant to provide definitive answers, but to illustrate the various components that should be taken into account. Each alternative is generally judged as to whether it is likely to:

- Increase Army personnel's knowledge and understanding of SWM, including improving data reliability and personnel skills
- Promote the pollution prevention hierarchy
- Maximize cost-effectiveness, which includes minimizing liability

- Demonstrate leadership, including addressing current problems, improving public perception, and enhancing the Army's ability to meet changing conditions.

5.2.1 Alternative A: Get Out of the SWM Business

Using this alternative, the Army would make a decision that facilities should not manage solid waste for themselves. Each facility would make contractual arrangements to handle its wastes whenever feasible. This policy might be more or less inclusive, covering: collection and disposal operations only (as many now do); collection/disposal and other parts of the program, such as recycling; or, planning/management responsibility in addition to specific services. This alternative could include additional features, such as whether facilities might allow their contractors to build and manage disposal facilities on the installation; that is, whether all processing and disposal must occur elsewhere. This discussion assumes that "getting out of the business" would entail more than contracting out disposal services only.

While Army policy regarding new landfills is a separate issue from whether to get out of the solid waste business, the two issues are probably interrelated. Discouraging new landfills would mean that installations must arrange to use facilities off base, or join local or regional efforts to permit and build new facilities. Banning or increasing Army requirements for new landfills would be an incentive for installations with landfills to contract out SWM as existing landfills reach capacity.

Assessment

This approach constitutes a reduction of overall Army involvement in SWM as a matter of policy. It seeks to remove the Army from direct SWM responsibility. Centrally very little oversight would be appropriate or possible.

Management disengagement would leave installations without an adequate knowledge or resource base to understand and assess SWM complexities and problems. If costs radically escalated, they would have fewer options. Further, installations have unreliable solid waste data now and it might become more difficult for facilities to collect accurate information about waste generation or trends if commercial interests are handling solid waste. Businesses would have little interest in minimizing Army costs, and accurate numbers for a facility would probably require additional work. Nor would facilities have strong incentives to gather such information, particularly if the number of solid waste slots decreases. A recent solid waste study found that some Army facilities gather solid waste data by counting containers rather than measuring volume or weight. This results in an overestimation of actual waste and most likely inflates payments to contractors (USACERL, 1991). Commercial solid waste managers have no incentive to correct overestimates.

A possible disadvantage of this approach is that turning SWM over to contractors might minimize attention to pollution prevention. It does not preclude pollution prevention approaches, but it does nothing to promote them centrally. The benefits of and opportunities for such reductions, including but not limited to cost savings, would simply be less obvious to installation personnel if they were not directly involved in planning and management.

Cost-effectiveness might be very roughly assessed by comparing the costs of current approaches, some of which are contractor operated, and commercial costs in areas where Army facilities would begin contracting. Key unknowns here are that available cost information does not reflect true costs; future costs, including siting, are increasing steeply in some areas of the country; and state/local governments might increase burdens for imported solid waste. Contracting out greater portions of SWM could increase total costs, since commercial operations include profits. Some cost studies indicate contract services might be cheaper, but other experts strongly disagree (Bailey, 1992). Some installations might find contracting for specific services to be the most cost-effective solution based on economies of scale, where personnel shortages are severe, or where the 1991 landfill rules create strong incentives to close landfills prematurely, to avoid more stringent requirements. A decision to allow no new landfills, regional or Army, on Army property could further increase the costs, and might lead to serious siting problems for new landfills, due to local opposition. These cost-effectiveness trade-offs refer to contracting out services. A decision to require that planning and management be contracted as well would entail more qualitative issues, for which cost-effectiveness would be very difficult to assess. Overall costs, while high, might not be a major factor in installation budgets. If this is true, costs would not be a determinate consideration.

Liability costs are potentially very significant in SWM, but Alternative A would not solve liability concerns. The Army cannot guarantee freedom from involvement if problems arise at facilities where its wastes go. The Army would most likely be identified as the deep pocket for compensation. While liability for Army-operated facilities is even more certain, the Army has more control over their management, and claims are less likely to arise on Army than on public lands. For new landfills meeting tighter federal standards, the issue is whether they would increase liability above that already present from older installation landfills.

The Army should consider a number of factors aside from cost-effectiveness. Establishing a policy of contracting out all SWM is unlikely to be seen as a symbol of environmental commitment. This is important if the Army seeks to be an environmental leader. While this policy would not preclude leadership at installations, it would not promote it. It could signal an "out-of-sight, out-of-mind" approach as Army policy. Army policy-makers might see this approach as the best way to address changing conditions, that is, reduced forces with contractors replacing personnel. The extent to which it would save personnel slots and training would depend upon whether installations contracted out disposal services only, or planning/management functions as well. Citing personnel shortages as the reason for getting out of the business would be unconvincing for large installations.

If Alternative A were chosen in conjunction with a policy to ban new landfills on Army property, the symbolic and political effects could be quite negative. It could make local disposal or regionalization very difficult to achieve, as the Army could not offer its land for disposal, even if it were the safest and most cost-effective solution. However, a policy to discourage new Army landfills is not incompatible with donating or selling Army land for a solid waste facility. This approach could support regionalization, improve Army relations with the locality, and avoid handling regional wastes on Army land.

5.2.2 Alternative B: Status Quo

This is the do nothing alternative. It would essentially leave the Army without a comprehensive, cohesive policy (only pieces); installations would continue to have complete control without effective reporting mechanisms, central guidance or coordination.

Assessment

The Army cannot confidently change or defend the status quo, as the Army does not have a reliable database. Further, even if solid waste does not present imminent, pressing problems, clearly the nation has to address the absolute and relative growth of solid waste. Solid waste volumes continue to grow, relatively and absolutely, as landfills close and capacity diminishes, rapidly in some areas. The Army might also want to develop effective means to oversee certain kinds of issues, and to broadly implement or encourage those approaches that are proven successful at individual facilities. Under the status quo, communicating requirements or exchanging good ideas is rather difficult.

Individual installations can pursue pollution prevention strategies, and some do, but most pursue recycling at best. The status quo is not effective at promoting source reduction Army-wide. Pollution prevention programs require not only actions on installations, but system-wide support and guidance that should come from HQDA.

Full costs are not currently counted, and available cost information is not accurate. Cost-effective and workable planning requires baseline information, and more integrated approaches than the status quo offers. The principal cost issues for this alternative are more accurate accounting of full SWM costs, and accurately projecting the sharp increases that at least some facilities will incur in the future. The status quo has high opportunity costs. Installations cannot develop more cost-effective programs if they do not improve planning and waste characterization, at least to prevent overpaying tipping fees. Although not discouraged, integrated SWM planning is not a necessity under the status quo. Current liability is unclear, but in any case, more or less centralization will probably not significantly affect liability. If costs skyrocket, as some predict in highly congested regions, costs would clearly be a larger factor. Otherwise, cost considerations are perhaps not pivotal for Alternative B, especially in the immediate future or when compared to overall Army installation budgets. In the short-term, moving away from the status quo would probably be motivated more by policy than cost considerations.

Choosing Alternative B implies not only that SWM is going reasonably well now, but also assumes that it will continue to go well with changing conditions, increased public and Congressional concern, pending reauthorization of RCRA, and passage of the new Federal Facilities Compliance Act. If there are indeed SWM problems to be solved, because of capacity problems, costs, fragmented management, or public concern, then the Army should have a clearer idea of its current practices and future needs. It is doubtful that the current fragmented system can encourage sufficient leadership to respond adequately to emerging problems and public concerns.

5.2.3 Alternative C: SWM Plan As Only Requirement

Alternative C constitutes a minimum Army-wide policy. It requires very little specific SWM activity beyond that already required by law, regulation, Executive Order, or Army and DoD directives. The Army would establish one critical requirement: that facilities develop individual SWM plans projecting a certain number of years into the future. HQDA would define Army-wide criteria for data quality, planning, and management, and thus generate a consistent database (see Table 4-1).

Army policy would specify categories to address, not program elements or objectives to accomplish. Each facility would be required to address certain issues and provide a rationale for its SWM program, but would design its own waste prevention and management processes, choosing the best solutions for its particular circumstances. These plans would present an overview of installation planning and management. They should be used to address the issues/concerns identified in Chapter 2. The Army should also specify who must review and approve the individual plans. Plans could provide the basis for additional Army-wide requirements or guidance in the future.

Assessment

SWM plans might be the only appropriate Army-wide requirement, especially as a first step. If the Army wants more consistency or centralized control, the requirements should be based on a firmer assessment of current conditions. SWM plans could provide the fundamental database for future Army decisions. The usefulness of these plans for Army oversight depends directly upon the quality and inclusiveness of the elements required in each plan. Army leaders should carefully consider what information is needed by facility, and then what is needed Army-wide, to assess and manage solid waste capabilities into the next century. For example, forecasting solid waste trends and issues nationally might not be feasible or useful; regional assessments might be most practical and useful.

SWM plans would be useful tools for installation leaders and should also enhance the Army's ability, at both installation and headquarters levels, to integrate program elements and meet changing circumstances. Comprehensive planning, including the data collected for planning purposes, would help target pollution prevention alternatives, and should help target impediments to pollution prevention both at the installation and Army-wide levels.

The cost-effectiveness of producing SWM plans should be assessed over several years. Facilities that currently do not have a reliable baseline or practice integrated solid waste planning could require significant resources to produce a SWM plan, particularly for the first year or two. On the other hand, improving the quality of planning would undoubtedly produce savings over the status quo, particularly at those facilities which now do little planning, by establishing the baseline data necessary for making cost-effective, workable decisions. Setting only minimal requirements provides flexibility to installation solid waste managers, and enables them to design the most efficient SWM program. Costs for creating SWM plans would vary widely, depending upon the size and type of facility, what sort of planning they currently conduct, and how much precision is expected. Because the plans should be based upon uniform criteria, even installations with good plans would likely have to modify them to some extent.

Costs of implementing program elements are separate from planning costs. Planning costs include the cost of gathering required minimum data. This could be a large cost, depending upon the degree of reliability needed for estimates. For example, a rough characterization of waste stream constituents costs only a fraction of the resources required to perform a rigorous analysis. Estimated expenditures will also depend upon how personnel time is reflected. Rough cost estimates, derived from informal contacts with several municipalities and installations, fall in a range of $50,000 to $200,000. Planning efforts should be commensurate with the installation's needs; providing uniform guidance from Headquarters would be critical to controlling costs and ensuring usable documents.

Requiring plans would signal a clear Army concern. Planning itself does not constitute leadership, but it is a necessary ingredient. Good planning gives installation and headquarters decision-makers the information and perspective needed to provide effective leadership. It does not guarantee integrated management, but it does encourage and make it possible.

5.2.4 Alternative D: Program with Additional Requirements

The Army would set general criteria and requirements in some areas; each facility would design its own SWM plan to meet or surpass these minimum goals. This alternative is equivalent to Alternative C plus some specified additions.

The possibilities under Alternative D are myriad. Army decision-makers would have to specify requirements or program elements to be achieved (see Section 4.1.3). For example:

- Stipulate conditions under which installations must/must not do certain things, such as site a landfill or incinerator on the installation, or set up a regional agreement for waste disposal. These conditions could be ecological (e.g., how close is groundwater?), or financial (e.g., cost criteria), or political (e.g., stipulate that HQDA and local government must agree)
- Require every facility to establish a recycling program, or to establish a program if certain categories (e.g., glass) exceeded some volume; further variations (and details) might be specified, such as: what materials must be re-

cycled, minimum program performance criteria, how the proceeds might be spent

- Require facilities to have SWM education/training/awareness programs; further details could include specifying a minimum level of effort (hours/capita), kinds or numbers of courses.

Assessment

As discussed in Chapter 4, this approach would be useful for establishing minimum Army performance goals or standards. The Army could institute some clear objectives for its SWM program by ensuring that certain planning or management steps would be universally practiced. Collecting the information essential to setting feasible requirements, together with installation efforts to address those requirements, would probably increase overall knowledge and understanding of SWM, particularly if training/education were a required element. Carefully selected central requirements could guarantee consistency in critical areas. On the other hand, given that existing Army solid waste data are generally considered to be poor, HQDA should be cautious to specify only requirements that are universally feasible and constructive. Increasing central requirements might decrease the flexibility installations need to integrate their program in the most cost-effective way. Even though exemptions could alleviate excessive burdens, designing the appropriate exemption criteria centrally would be a rather difficult task without better information.

Criteria or standards might be established that promote pollution prevention, but the effectiveness of this alternative would depend entirely upon the quality of the requirements HQDA selects.

The cost-effectiveness of this alternative would depend entirely upon how many and what kinds of specific requirements were instituted. Activities that would increase effectiveness at some installations might decrease it at others. For example, installations that have already initiated strong programs might be hindered by additional specified requirements. Cost-effectiveness could be controlled by setting cost cutoffs, that is, granting exemptions to any installation where costs would exceed some absolute amount or cost/capita. Given the great diversity among Army facilities, cost-effectiveness could only be assured by creating such cutoff criteria. Assessing costs would be far easier and more reliable if there were baseline data available.

With carefully chosen requirements, Alternative D might demonstrate leadership which provides clear Army direction and improves public perception. Central guidance and assessments could better prepare the Army for the complex, changing conditions of SWM. Army leadership must state requirements in such a way that installations which have shown initiative in the past, do not inadvertently get penalized. For example, an installation may be penalized if it has to meet goals tied to a baseline year when their baseline has already been significantly affected by ambitious program goals. Misdirected, unachievable requirements could have very negative effects and further emphasize weaknesses in SWM in both failed programs and in attitudes.

5.2.5 Alternative E: More Centralized Policy

This approach would increase the number of uniform requirements compared to Alternative D. The Army would set minimum standards for various solid waste prevention and management tools (see Chapter 4) with criteria for exemptions if necessary. Given the wide variety of installations and needs, requirements and goals would be stated as rebuttable presumptions to allow for deviation when reasonable.

The policy would specify general installation requirements or goals for source reduction, recycling, education and training, disposal, and incentives. It would require that key facility personnel have SWM objectives specified in their performance standards. These would be tracked and reported, and performance evaluations would have to assess success in these areas. This policy approach would set an Army position about the desirability of pursuing regionalization and conferring with localities on SWM issues. This policy would define requirements or criteria to build incinerators or landfills. Criteria could be based on population density, cost for land, and nearness of groundwater. A central clearinghouse for information and assistance would be especially needed for this approach.

Assessment

This alternative would be prohibitively difficult without gathering reliable baseline data and assessing system-wide issues and problems before taking action. If the Army wants to move in this direction, then it should make sure that appropriate data are collected that will facilitate making further policy decisions within a few years.

Arguably, more centralized planning could promote pollution prevention more quickly and effectively than depending upon installations to assess and implement possibilities individually. From a cost-effectiveness perspective, this would be the most difficult and costly policy to initiate. More centralized control and accountability would probably convince the public that Army leadership is dedicated to effective, integrated SWM. It might be useful for SWM planning to have clearly stated, Army-wide objectives; it might settle some issues and quiet constant rumors about impending new policies (e.g., no new landfills). However, the process of setting uniform standards and deciding on exemption criteria would in itself be burdensome, and a centralized system could frustrate installation-level leadership and innovation. Once such a policy were set, it would presumably need some kind of central oversight process. Any policy should be overseen, but the more complex the policy, the more complex and hence costly the oversight requirements.

Perhaps more important, differences across Army installations (in waste generation and characteristics, in recycling opportunities and markets) would mean that any uniform policy would probably contain more exceptions than rules. It is questionable how helpful general requirements are in this context. If requirements must be broad and vague to be practical, then they may not be very useful; worse still, there may be a constant call for guidance on a variety of issues. Installations would probably resist this approach. It would represent a considerable loss of autonomy for installation commanders, and could soak up unacceptable resources in compliance or in justifying exemptions.

5.3 Summary

Looking at SWM nationally and in the Army context, it is clear that the issues and factors are very complex, with diverse local realities to address. Solutions should therefore be tailored to address unique installation missions, combinations of problems, conditions, and prices. At the same time, Army HQ should work to resolve certain issues, some of which go beyond Army authority and require agreement at the DoD or Congressional level.

Integrated planning requires consistency across time to assess alternatives and approaches; it cannot occur without accurate data (including full cost data) based on sound definitions and coordination at both planning and implementation stages. For Army HQ, it is important that some fundamental definitions be commonly used across installations, so that the Army can provide oversight, support, and guidance. Army-wide policies and programs should set goals and expectations, while creating opportunities and incentives for innovation.

Defining categories and collecting data are formidable but necessary tasks to establish a basis for important policy choices. The first step, and the most critical short-term objective, should be to establish some broad definitions and gather baseline data for certain minimum categories or program elements. Because of the associated expense, the Army should carefully consider which data elements are most important to good SWM. After taking this initial step, the Army can further identify problems, define alternatives and weigh trade-offs, and then decide whether and to what extent it wants to establish additional, perhaps more detailed policy objectives or requirements.

Table 5-1 Summary of Alternatives

Alternatives	Objectives: C E	Objectives: Leadership	Objectives: Knowledge Understanding Data	Objectives: Pollution Prevention (P2) Hierarchy	Implementation
A Get out of SW	• Variable but costs incl profit • In some locations very costly • Liability neutral • Increases siting problems	• Probably negative, esp if planning/mgmt contracted or if "no new landfills" policy adopted • Doesn't address Amy issues except insofar as eliminated	• Limited in relation to amount contracted	• Not addressed • Neutral to negative effect	• Decide how much to contract • Decide whether contracts are installation or HQ-based • Give guidance for trigger date/event • Disseminate decisions
B Status Quo	• Unknown but not maximized	• Negative, in continuing fragmentation • Doesn't address Army issues • Flexible	• Insufficiencies continued	• Not generally understood or practiced	• Nothing required
C SWM Plans	• Plans potentially expensive, but improves SWM C E in relation to Plan quality	• Estab minimum Army wide policy • Future-oriented • Addresses Army issues • Flexible	• Key element	• Encouraged by structure of Plan	• Decide on elements of Plans • Develop guidance on writing a plan • Develop guidance/methodology on minimum data reliability • Develop guidance/methodology on true cost acctg • Decide who has review authority for Plans • Decide whether to initiate audit/evaluation system—if so develop guidance • Work on incentive system
D Some Centralization	• Highly variable • Impossible to assess now	• Addresses Army issues • Army HQ leadership enhanced beyond Alternative C	• Key element	• Could strongly promote	• C ABOVE plus • Further assess certain program elements prior to setting requirements • Guidance for specified elements of program including cutoff/exemption criteria
E More Centralized	• Probably not C-E, esp for some installations • Developing exemption criteria costly difficult	• Addresses Army issues • Army HQ appears strong probably detrimental to installation level • Could backfire if program un-doable	• Essential • Goes beyond current knowledge/data	• Could strongly promote w/ exemptions properly structured • Danger of frustrating installation flexibility for P2	• D ABOVE plus • Problems of data availability as specificity increases

6. Implementation

Chapter 5 covered Army SWM policy alternatives. This chapter addresses the implementation of each of those alternatives. This chapter does not present a step-by-step program or a comprehensive discussion of issues. Instead, it provides direction and identifies needs for implementing the alternatives discussed in Chapter 5.

Once policy-makers have chosen SWM policy direction, they must decide how to promulgate the policy. This could be done, for example, through a statement or directive which supersedes previous ones, with perhaps an explicit amendment of related Army directives as needed for consistency. Policy-makers also need to determine what in the Army-wide SWM program is reviewable. Several of the alternatives require guidance to help installations carry out the policy. Specific decisions and guidance for each alternative are discussed in this chapter.

The relative simplicity of Alternatives A and B makes them easier to implement at the HQDA level. To implement Alternative A (get out of the solid waste business), the Army should decide the scope of the responsibilities to contract out (i.e., pick-up and disposal only, or solid waste planning and management as well). Army HQ should also determine what is able to be contracted. This decision should be based in part on whether or not contracts are to include planning and management components, because these services would be very difficult to arrange through a central Army contract. Finally, policy-makers need to set the start date or triggering event for getting out.

Guidance would help installations fulfill their requirements under Alternative A, but would not be imperative. The Army could provide counsel to those responsible for contracting (installation, MACOM, or HQ). This might help them create and negotiate a contract, monitor the quality of contractor services, and renew the contract. The Army could provide information on what constitutes good SWM services, including schemes for collection which minimize property damage and noise, locating dumpsters in appropriate places, and collection and processing which maximizes recycling.

For implementing Alternative B, no new actions are required. Installations could clearly benefit from additional guidance under the status quo, but Alternative B does not suggest any particular areas for guidance.

If the Army selects Alternatives C, D, or E, it must make a few more central decisions. If Alternative C (the SWM Plan Only option) is chosen, policy-makers must decide upon the required elements of a SWM plan. In doing so, they should define key terms, such as municipal and industrial solid waste. This study includes a draft list of elements for a plan (Chapter 4). Decision-makers should also decide if they want Army-wide oversight, determine who has review authority for plans, and decide whether to implement a feedback system, such as an auditing and/or evaluation program. Finally, the Army must decide when the first plan is due and how frequently installations must review their plans.

Because Alternative C gives installations great freedom within plan requirements, installations have many options. Army consultants might help installations determine their overall approach and assess their options. This guidance could help in dealing with technical and management concerns. To effectively help installations, a how-to manual for developing a SWM plan is essential. Specifically, the manual could instruct planners on how to assess a number of factors, including installation waste streams, solid waste weight or volume, full cradle–to–grave SWM costs, land use classifications, regional population density, markets for recyclables, availability and cost of recycled materials, and community relations regarding Army SWM. Solid waste managers should know how to keep abreast of new waste prevention and recycling technology (e.g., through a clearinghouse).

Additional guidance could be very helpful, though perhaps not essential, such as in guidance for site selection, help in assessing the advantages/disadvantages of incineration, or guidance in monitoring and evaluating programs. Models for this guidance and program development already exist, at individual installations and in the private sector. Army guidance would therefore build upon existing research and experience to address Army-wide issues and needs. Installations could also want help in addressing management issues to maximize the effectiveness of SWM planning, particularly how to make the system function most effectively. Issues for which further direction might be helpful include: developing incentives, performance evaluation criteria for different jobs/levels, training policy for different levels of responsibility, and designing education and awareness programs. If the Army wants to establish Army-wide oversight, feedback, or evaluation, another implementation issue will be to adopt an audit system, perhaps using ECAS as a model.

If policy-makers want to go beyond requiring only a SWM plan by moving toward more centralization (i.e., toward Alternative D or E), they will have to determine what to require, and what cutoffs or exemptions to set. To set the appropriate criteria, policy-makers will in some cases need additional information or analysis (Alternative C makes installations responsible for these analyses). Policy-makers will want to take regional conditions, for example, population size and density, land use classifications, and markets for recyclables into account to provide sufficient flexibility across installations. They should make general requirements flexible enough to enable installations to take advantage of emerging technologies.

Once the criteria and requirements are established, the Army will need to provide guidance on these additional requirements and cut-off criteria. Whereas the amount of guidance critical for implementing Alternative C is relatively modest, Alternative D's additional requirements would increase the need for guidance to installations. The kinds of guidance needed would depend upon the central requirements and recommendations chosen. For instance, installations might need help in negotiating regional agreements if on-post landfilling is a more limited option; they might need guidance to identify markets for recycled materials, or present required education/ training courses.

Implementing Alternative E would require the same efforts as for D, plus some additional decisions and guidance. Cutoff or exemption criteria would be more critical as requirements increase. The Army might target key installation personnel, and add SWM elements to their performance evaluation. Also, policy-makers might choose to expand the audit of installation performance. The Army performs audits once every four years through ECAS; during the beginning stages of this policy, the Army might want to audit installation SWM programs more frequently. In addition, the Army would need to create one or more dependable SWM clearinghouses, or add SWM information to an existing Army clearinghouse. To do this, the Army would need to determine what information would be most useful to installation personnel, then collect this information, or know how to direct people to the right information. The Army should take advantage of clearinghouses which exist outside of the Army.

To improve recycling policy set by DLA or incorporate source reduction criteria in procurement policy within GSA, the Army would need to influence SWM policy at the DoD level. The DoD Solid Waste Committee could provide an important mechanism for addressing these issues. The group addresses DoD policy in procurement, innovative recycling techniques, industrial fund (IF) activities, and installation recycling programs, including marketing and sale of recyclable materials. The Army should actively participate in this committee to improve DoD SWM policy.

Decision-makers might choose a phased approach. The first phase would focus on Army-wide data collection, planning, and assessment. Installations must complete these tasks to create a SWM plan. The Army could compile some of this information to form an Army-wide picture. Based on Army-wide data, the Army might proceed to highlight potential initiatives such as pollution prevention, incentive strategies, and improving SWM technology. The compiled data might also point out regional and seasonal conditions which affect SWM program effectiveness. Further policy studies on research could be targeted after assessing data collected in the early phases. Based on more and better data, the Army could later decide to further centralize certain aspects of SWM policy.

7. Conclusion

The nation and the Army share many concerns in managing solid waste. These include: reduced number of landfills, increased costs for waste disposal and increased regulation. The Army faces additional issues because of poor data and fragmented solid waste organization at the installation and headquarters levels, both of which inhibit integrated SWM. After analyzing Army specific and national problems, this study found four general areas of concern that help define a foundation for improving Army SWM. These areas are: information collection and analysis to accurately describe the waste stream, management and organization to foster integrated waste management, incentives to improve waste management; and training/ communication to prepare personnel. These areas of concern and their corresponding issues provide a starting point for improving Army SWM. Strategies to improve planning and management must combine initiatives at the installation and HQ levels.

The Army has not faced significant compliance problems with solid waste at its existing 51 municipal landfills, although there are several 'landfills used primarily for industrial waste disposal that contribute to contamination on NPL sites. However, compliance problems may rise as regulations for operating and closing landfills increase. New federal policies and state laws are requiring installations to develop recycling programs. Expanding recycling programs, however, may be hampered by fragmented organization and current DLA policies on using DRMO to market secondary materials. New requirements under pending legislation (reauthorization of RCRA and the soon-to-be-enacted FFCA) will add additional complexities to SWM.

This paper provides a framework to begin improving Army SWM by:

- Improving waste characterization and personnel training
- Integrating the pollution prevention hierarchy in SWM
- Using full cost accounting to promote cost effectiveness
- Exercising a leadership role in SWM.

The study defines four major categories of tools that, when used together, facilitate integrated SWM. Decision tools describe how to evaluate solid waste decisions and prepare integrated plans. The SWM plan provides a framework for utilizing all of the other tools and is a key component for a successful program. Waste prevention tools identify approaches to reduce solid waste at the source. The waste handling tools provide approaches for recycling and disposal. Once decisions have been evaluated and solid waste plans completed, implementation tools are available to work with regional solid waste authorities, train and educate personnel, and develop informational clearinghouses.

The broad-based alternatives offer a framework for managing solid waste. The choices begin with determining an appropriate level of centralized control of installation solid waste planning and management. Once the Army decides on the level of consistency and centralized planning needed, further analysis on certain issues may be appropriate. The alternatives focus on the need to: improve integrated planning, establish basic definitions, collect baseline data, and facilitate coordination and leadership of Army SWM.

Implementing the strategies identified in this policy analysis could take the form of new policy and guidance on SWM depending on which alternative is chosen. Some additional requirements may be necessary to implement solid waste planning, improve data collection, and incorporate source reduction criteria in Army decisions. A how-to manual could provide installations with information to develop integrated plans that cost effectively implement the pollution prevention hierarchy.

Solid waste will be an increasingly difficult issue to address as the number of landfills continues to decrease while compliance requirements increase at the federal and state levels. Meeting future challenges will require integrated management that emphasizes the EPA pollution prevention hierarchy, full cost accounting, strong leadership, and a clear understanding of solid waste characteristics. Obtaining these objectives will help reduce liability and compliance costs, save natural resources, and reduce environmental risk. If the Army carefully considers its solid waste needs for the next several decades, it can proceed in a series of decisions and actions to integrate an Army-wide approach based on sound data, persuasive leadership and achievable goals.

Acronyms

AAA	Army Auditing Agency
ACE	Assistant Chief of Engineers
AEHA	Army Environmental Hygiene Agency
AEMIS	Army Environmental Management Information System
AEPI	Army Environmental Policy Institute
AMC	Army Materiel Command
APG	Aberdeen Proving Ground
ASA(IL&E)	Assistant Secretary of the Army for Installations, Logistics, and Environment
ASA(RDA)	Assistant Secretary of the Army for Research, Development, and Acquisition
BACT	best available control technolo[illegible]
BRAC	Base Realignment and Closure
Btu	British thermal unit
CAA	Clean Air Act
COE	Corp of Engineers
CONEG	Coalition of Northeast Governors
CONUS	Continental United States
CY	cubic yards
DASA	Deputy Assistant Secretary of the Army
DASD	Deputy Assistant Secretary of Defense
DCSLOG	Deputy Chief of Staff for Logistics
DCSOPS	Deputy Chief of Staff for Operations and Plans
DEEBBS	Defense Environmental Electronic Bulletin Board System
DEH	Directorate of Engineering and Housing
DLA	Defense Logistics Agency
DoD	Department of Defense
DPCA	Directorate of Personnel and Community Activities
DRMO	Defense Reutilization Marketing Office
DRP	DoD Recycling Program
ECAS	Environmental Compliance and Assessment System
EHSC	Engineering and Housing Support Center
EIC	Environmental Information Connection
EPA	Environmental Protection Age[illegible]
ESOH	Environmental Safety and Occupational Health

ETIS	Environmental Technical Information System
FFCA	Federal Facilities Compliance Act
FORSCOM	Forces Command
GOCO	government owned contractor operated
GOGO	government owned government operated
GSA	General Services Administration
HQDA	Headquarters, Department of the Army
HQTRADOC	Headquarters, Training and Doctrine Command
HQFORSCOM	Headquarters, Forces Command
HRI	heat recovery incinerators
I&H	Installations and Housing
IF	industrial fund
IL&E	Installations, Logistics, and Environment
IPC	Intermediate Processing Centers
MACOM	Major Command
MRF	Material Recovery Facilities
MSW	municipal solid waste
NEPA	National Environmental Policy Act
NG	National Guard
NIMBY	Not In My Backyard
NOV	Notice of Violation
NPL	National Priority List
OACE	Office of the Assistant Chief of Engineers
O&M	Operation and Maintenance
OTA	Office of Technology Assessment
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RDA	Research, Development, and Acquisition
RDF	refuse-derived fuel
RPMA	Real Property and Maintenance Account
SMSA	Standard Metropolitan Statistical Area
SW	Solid Waste
SWICH	Solid Waste Informational Clearinghouse
SWM	Solid Waste Management
TIPPP	Tidewater Interagency Pollution Prevention Program
tpd	tons per day

tpy	tons per year
TRADOC	Training and Doctrine Command
USACERL	U. S. Army Construction Engineering Research Laboratory
USATHAMA	U. S. Army Toxic and Hazardous Materials Agency

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Appendix A

Army NPL Solid Waste Sites

Installation	MACOM	Description
Anniston Army Depot	AMC	Low levels of contaminants found in ground water outside installation boundary partially due to a landfill area.
Fort Dix	TRADOC	Plume of contaminated ground water was coming from the landfill
Fort Lewis	FORSCOM	Landfill was determined to be contributing to ground water contamination
Fort Devens	FORSCOM	Remedial investigation of two landfills initiated in September 1990.
Fort Riley	FORSCOM	Toxic and hazardous materials from closed installation landfill have the potential to contaminate off-post groundwater.
Fort Ord	FORSCOM	Landfills suspected of contaminating city of Marina's backup supply well.
Iowa Army	AMC	Ammunition Plant waste lagoons have contributed to groundwater contamination.
Lake City Army	AMC	Oils/greases, heavy metals, solvent contamination from Ammunition Plant landfill and lagoon
Lone Star Army	AMC	Undrummed wastes in landfill has contributed to Ammunition Plant potentially contaminating ground-water off the installation
Longhorn Army	AMC	Old landfill contributing to contamination of surface and Ammunition Plant groundwater.
Riverbank Army	AMC	Ammunition Plant abandoned landfill contributing to ground water contamination.

Senneca Army Depot	AMC	Potential for ground water contamination from an ash landfill
Tooele Army Depot	AMC	Potential ground water contamination from an industrial waste lagoon.
Twin Cities Army	AMC	Two industrial/building landfill sites contributing to ground water contamination
Umatilla Army Depot	AMC	Washout lagoons contributing to groundwater contamination

Source Department of Defense, Defense Environmental Restoration Program Annual Report to Congress for Fiscal Year 1990, February 1991.

Appendix B

Example Cut-off Criteria for Landfills

	EPA Regulation	Management Cut-off Criteria
Surface Water	An MSWLF shall not cause a discharge of pollutants into waters that would violate CWA or cause the discharge of a nonpoint source of pollution that violates any State water quality plan approved under section 208 or 319 of the CWA (40CFR258 27)	• Avoid siting that will disrupt natural drainage patterns • Avoid siting in estuaries or in riparian areas • Site landfill at least 1 000 feet from lake, stream, or river
Seismic Impact Zones	MSWLF units shall not be located in seismic impact zones, unless it can be demonstrated that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site (40CFR258 14)	U S Geographic Survey provides maps to determine seismic instability in a region MSWLF sites should be located where soil types and geological characteristics minimize the impacts of seismic instability
Endangered Species	Facilities will not cause or contribute to the taking of an endangered species (40CFR257 3)	Do not locate a landfill where it could impact the habitat of an endangered or threatened species
Soils	No federal regulations States may have soil regulations	Sites with silt and clay soils are optimal since they restrict leachate and gas movement
Topography	No federal regulations States may have maximum slope regulations	Site on land with less than 5% slope
Landuse	No federal regulations State and regions may have landuse requirements for landfills	• Try to locate in rural or in industrial areas • Locate downwind of residential recreational, and commercial landuse
Ground Water	• A facility shall not contaminate an underground drinking water source (40CFR257 3)	Avoid siting where depth to groundwater is less than 25 feet.
	• New MSWLF units must be in compliance with the groundwater monitoring requirements specified in 258 51 55 before waste can be placed in the unit (40CFR258 5-4)	Avoid siting in aquifer recharge area.
Airport Safety	MSWLF within 10 000 feet of turbo jet airport and 5 000 feet from poston plane airport must not pose a bird hazard to aircraft (40CFR258 10)	Ensure adequate soil is available to spread at least six inches of covering on the landfill
Floodplain	Floodplain must demonstrate that unit will not restrict the flow of the 100-year flood Must not reduce the temporary water storage capacity of the floodpan or result in washout of solid waste (40CFR258 11)	• Avoid siting within 300 feet of a 100-year flood plain • Many states have specific siting guidance for floodplains
Wetlands	New MSWLF units and lateral expansion shall not be located in wetlands (40CFR258 12)	Siting in wetlands significantly increases the potential for leachate to contaminate surface and groundwater In addition wetlands provide valuable habitat that may be disrupted by landfill operation

Appendix C

Incinerator Capital and O&M Costs

Typical Capital Cost for Modular HRI Plants

Installed Capacity (xpd)	24	50	125
Annual Waste Burned (tpy)	2,412	13,125	35,000
Plant Construction	$1,648,000	$3,393,000	$8,186,000
Air Pollution Control	$0	$400,000	$1,620,000
TOTAL COST	$1,648,000	$3,793,000	$9,806,000

Source. Salimando, 1987

Typical Operating Costs for Modular HRI Plants

Installed Capacity (xpd)	24	50	125
Annual Waste Burned (tpy)	2,412	13,125	35,000
Labor	$40,000	$200,000	$400,000
Auxiliary Fuel (oil)	$8,500	$45,900	$122,500
Electricity	$4,600	$24,900	$66,500
Maintenance & Repair	$36,200	$196,900	$525,000
Air Pollution Control	$0	$12,600	$63,000
Total Annual O&M Costs	$89,300	$480,300	$1,177,000
Annual Fuel Savings	$117,600	$516,800	$1,575,000
NET O&M COSTS	+$28,300	+$36,500	+$398,000

Source· Salimando, 1987

Glossary

Composting - A biological process that allows microorganisms to decompose waste into a soil conditioning product.

Incineration - Using controlled combustion in an enclosed device to reduce the volume of solid waste. Can also include mechanisms for recovering the energy generated from the combustion.

Leachate - Liquid that has percolated through solid waste or another medium and has extracted, dissolved, or suspended materials from it, which may include potentially harmful materials. Leachate collection and treatment is of primary concern at municipal waste landfills.

Lifecycle - The projected life of the system, subsystem, or component being evaluated. The stages of a component's lifecycle include development, procurement, operation, maintenance, and support, as well as demilitarization and disposal.

Lifecycle Analysis - Evaluation and projection of the life of the system, subsystem, or component considering development, procurement, operation, maintenance, and support of the system, as well as demilitarization and disposal.

Lifecycle Costs - Costs incurred during the projected life of the system, subsystem, or component during the process of evaluation. Includes all costs from the development, procurement, operation, maintenance, and support of the system to its demilitarization and final disposal.

Municipal Solid Waste - Includes non-hazardous waste generated in households, commercial and business establishments, institutions, and light industrial process wastes, agricultural wastes, mining wastes and sewage sludge. In practice, specific definitions vary across jurisdictions.

Non-municipal Solid Waste - Other RCRA Subtitle D wastes—these wastes are not part of municipal trash, but are not categorized as "hazardous" (Subtitle C) wastes. They include many industrial wastes.

Recycling - A process to collect, transform or remanufacture materials otherwise destined for disposal.

Reuse - Using a product more than once in its same form for the same purpose; e.g., bottles that are returned to the bottling company for refilling, are being reused.

Source Reduction - Minimize the quantity and/or toxicity of waste produced at the place of origin through the design, manufacture, acquisition and reuse process. Source reduction prevents waste either by redesigning products and processes, or by otherwise instilling behavioral changes in consumption, use, and waste generation.

Subtitle C - The hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle D - The solid, non-hazardous waste section of the Recovery Conservation and Recovery Act (RCRA).

Subtitle F - Section of the Resource Conservation and Recovery Act (RCRA) requiring the federal government to actively participate in procurement programs fostering the recovery and use of recycled materials and energy.

Tipping Fee - A fee charged to unload or dump waste at a landfill, transfer station, recycling station, or waste-to-energy facility; also called a disposal or service fee.

Trash - Material considered worthless, unnecessary or offensive that is usually thrown away. Generally defined as dry waste material, but in common usage it is a synonym for garbage, rubbish, or refuse.

Waste Stream - The total flow of solid waste from homes, businesses, institutions and manufacturing plants that must be recycled, incinerated and finally disposed of. Can also be a portion of the total, such as the "residential waste stream" or the "recyclable waste stream."

Waste Characterization - A study and/or process defining component parts of the waste stream according to source or type.

Waste Handling - Physical procedures and tools used for sorting, transporting and disposing of solid waste.

Waste Management - The whole range of programs, techniques and tools used to plan and execute the management of the solid waste stream.

Waste Prevention - Planning and tools used to reduce the volume or toxicity of waste through product redesign or substitution of materials. Sometimes used synonymously with Source Reduction.