

**ADVANCED  
CONSTRUCTION & DEMOLITION  
WASTE MANAGEMENT  
FOR FLORIDA BUILDERS**



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## **Manual Purpose**

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The intent of this manual is to provide information and methods to the developer, builders, designers and owners of construction and demolition projects to assist in reducing the amount of waste generated during the entire construction and demolition process. Reducing waste demonstrates corporate responsibility, provides compliance with local government waste reduction goals and ultimately reduces overall project cost. After determining the company's commitment level and the ability if any to alter building design and construction techniques, builders can begin simple steps to reduce the waste created.

Advanced Construction Waste Management involves designers and builders. It is necessary to:

1. Assess probable waste stream prior to construction
2. Directly involve local haulers, processors, and recyclers
3. Work with subcontractors on specific measures such as Waste Reduction, Recycling, and Reverse Distribution
4. Incorporate specific procedures and requirements into contract language
5. Provide training for ALL supervisors and workers
6. Emphasize clean site: Continuous cleanup, end of day wrap-up
7. Measure waste in volume, translate it into weight
8. Publicize your results

This manual will focus on complying with the goals set in the LEED Green Building Rating System Version 2.0. These intentions include diverting construction, demolition, renovation, and land clearing debris from landfill disposal, and redirecting recyclable materials back to the manufacturing process (USGBC, 2000). The strategies presented will address the requirements the LEED system has outlined, namely the development and implementation of a waste management plan that would allow for the recycling and /or salvaging of at least 75% (by weight) of the construction, demolition, renovation, and land clearing waste (USGBC, 2000).

Every construction and renovation project should have a waste management plan to avoid unnecessarily high disposal costs, reduce the amount of material consumption, and to reuse and recycle as much of the discarded material as possible. This manual will increase construction and demolition waste management awareness, make waste reduction, reuse, and recycling a job-site priority, and help establish waste prevention as a project goal.

## Introduction

Three types of waste dominate Florida’s MSW (Municipal Solid Waste) stream: paper, yard waste and **construction and demolition (C&D) debris**. These three components comprise an estimated 68% of the State’s MSW collected during 1996 on a weight basis. When compared to national waste composition data, Florida’s MSW exhibits a higher percentage of C&D debris. Waste composition data indicates that the percentages of each type of waste component remain fairly constant with the exception of C&D debris and yard waste, both of which have increased.

### CONSTRUCTION AND DEMOLITION WASTE STREAM

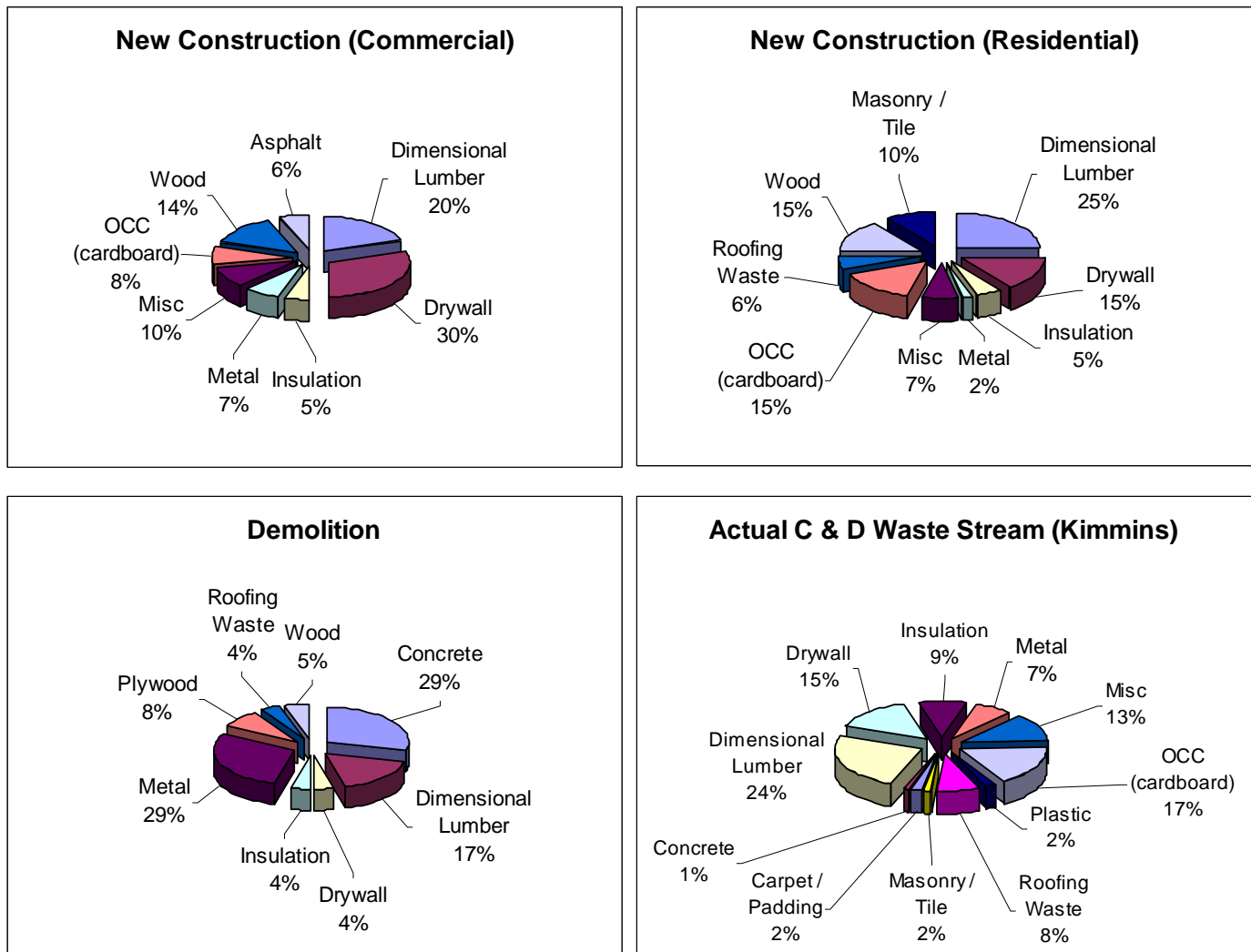
There have been many uncertainties surrounding actual accurate accounts of the C&D waste produced by the construction industry because of the highly variable nature of its generation. However, in recent years more information has become available on the amount and characterization of C&D waste in the U.S., the diversion potential and associated costs of waste management, and markets for recovered C&D materials.

**The amount of waste generated from construction projects can be as high as 15% of all materials used in the project.** It is estimated that residential construction generates upwards of 7 lbs. of waste per square foot of new construction. Currently construction and demolition (C&D) debris account for 33% (over 9.4 million tons) of the solid waste collected in Florida each year. Only a small percentage (20%) of this C&D waste is currently recycled (FDEP, 2001). Exact percentages of components of the C&D waste stream depends upon specific project type, however, the main components of the C&D waste stream remain constant. Table 1 contains a list of the main components of C&D debris and indicates the current disposal options for each.

Waste Component	Reuse	Recycle	Composting	Burning	Landfill
Asphalt / Roofing Waste					
Carpet / Padding					
Concrete					
Dimensional Lumber					
Drywall					
Insulation					
Metal					
OCC					
Plastic					
Masonry / Tile					
Wood					

**Table 1: Disposal options for C&D waste components**

Waste stream varies according to construction type, i.e. residential, commercial, or demolition. The figures on the following page show the percentage breakdown according to construction type. Figures 1a, b, c, and d show the percentage breakdown of the waste stream created from each of these construction types and an actual waste stream analysis conducted by Franklin and Associates (U.S. EPA, 1998).



**Figure 1: Waste Percentages by Construction Type (U.S. EPA, 1998)**

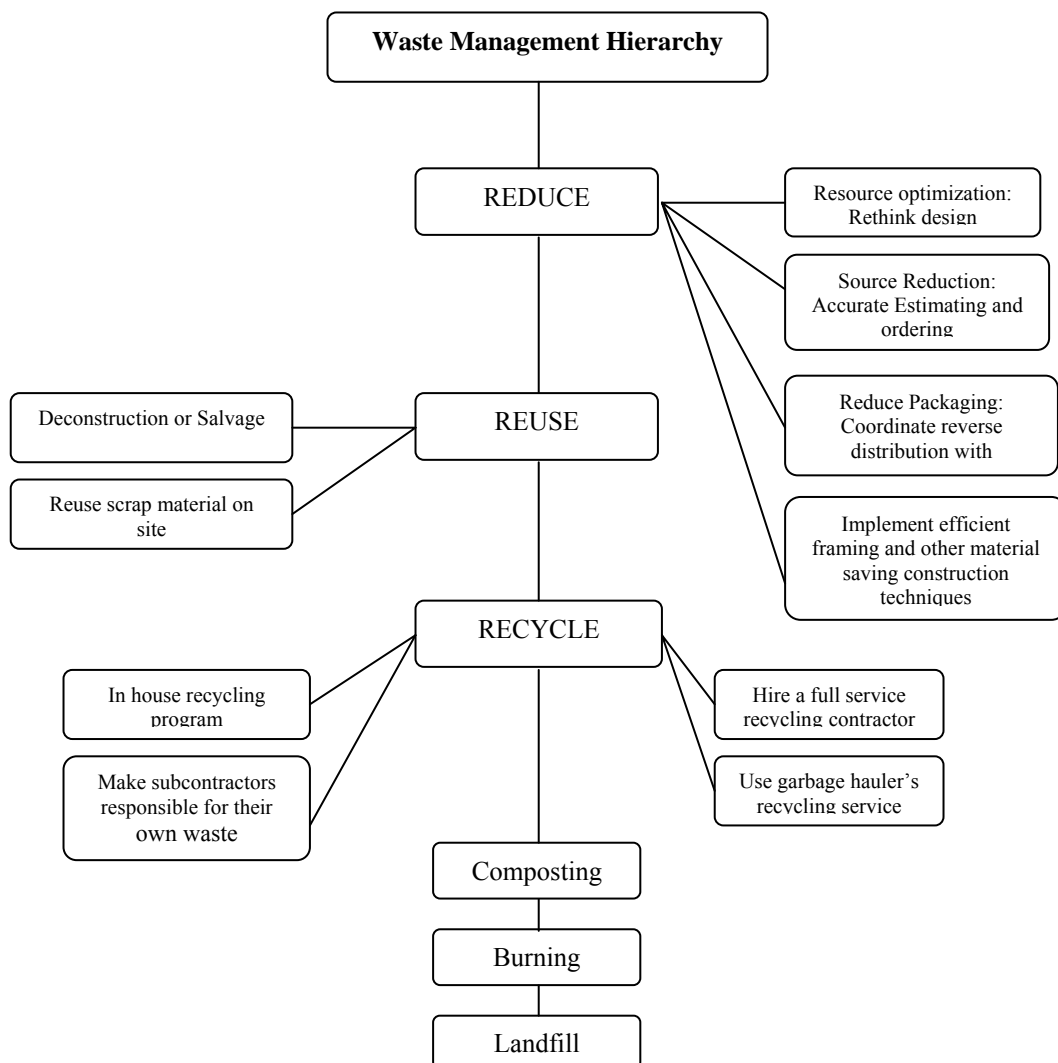
The importance of these numbers should not be taken lightly. Knowing the type and quantities of specific waste generated facilitates waste reduction and cost effective waste management techniques. What is important here to note, is that only a few items create the majority of your waste stream. The majority of the C&D waste stream is comprised of wood, concrete, drywall, roofing materials, cardboard, and metal.

Waste characterization and quantities differ from each of these processes as a function of the type, size, method, materials, and location of the project. The quantities and types of waste materials generated at typical job sites will strongly influence the exploration and development of waste management alternatives to disposal, making it important to not only identify the material components, but their contents as well.

## WASTE MANAGEMENT HIERARCHY

The waste management process consists of material reduction in the design and planning stages, reducing scrap and waste at your building site, reusing materials on site, and recycling materials you cannot reuse yourself. The intention of this manual is to address methods and potential alternatives to conventional construction techniques, planning practices, and waste disposal options to incorporate the concepts of advanced waste management techniques as well as their costs and benefits.

The most important step in reducing the solid waste management burden is reducing the amount of waste generated. Note the waste management hierarchy illustrated in figure 2. The most important step is reducing, followed by reusing, recycling, composting, burning and as a last result, land filling.



**Figure 2: Waste Management Hierarchy (Kibert & Lanquell, 2000)**

**Reduce**, also referred to as Source Reduction or Resource Optimization is the first and most important step in materials efficiency and waste prevention practices. Reducing involves actions to eliminate or reduce the amount of materials used on site, before they enter the solid waste stream. An example would be reducing the amount of packaging that comes on site, or using efficient framing techniques (See Section REDUCE). Another key component in reducing is changing design principles and practices. The architect has the ability to design structures on a modular basis, which lends itself to the use of standard size materials. In addition to modular design, accurate estimating is extremely important. Any excess materials brought to the construction site will ultimately be used, wasted or stolen. Materials are rarely transported to other job sites for use. The key to reduction is planning; by thoroughly planning throughout the entire construction process reduction is easily facilitated.

**Reuse** is the second level of the waste management hierarchy. It is the next step in materials efficiency and waste prevention. Effective reuse preserves the present structure of a material or article and does not require additional time or energy for utility. Examples of reuse include the immediate reuse of materials on site extracted from a demolition / **deconstruction** (See Section DECONSTRUCTION) project, or reusing left over materials for a future or ongoing project at another site. The reuse concept also incorporates the concept of *Re-buy*. Re-buy means not only purchasing salvaged materials, but involves purchasing products that are designed for source reduction and or constructed from recycled materials. This practice encourages market and technology development for materials and products that conserve resources and prevent waste, such as used building material centers.

**Recycling** is the next level in the waste management hierarchy. This step involves separating your waste into recyclable and non-recyclable materials. In this step, your recyclable waste is in some way reused; often to manufacture new materials with recycled content. By replacing virgin materials with recycled feedstock, natural resources and energy are preserved. Additionally, recycling contributes to the economy, both in providing jobs and in providing business opportunities. In Florida alone, over 13,000 people are employed by the recycling industry.

**Composting** will also reduce the amount of waste produced. Construction and demolition debris, tree limbs, and other fibrous organic material may be ground to produce wood chips, mulches, and as feedstock for composting. If the site layout provides an area to store the compost, it may be kept and used to landscape the project. The compost may be marketed to landscaping firms for commercial use or given away on a first come first serve basis. Compost can be used as a soil amendment, artificial topsoil, or growing medium amendment.

**Burning** where permitted should be one of the last alternatives for C&D waste. Caution must be used when burning to avoid adverse health effects as well as uncontrolled burns. Many communities have waste-to-energy incineration plants for combustible materials, however most of the materials used during construction are inappropriate for incineration.

**Land filling** should be the final alternative used for waste disposal. Many of the items that end up in the landfill are reusable or recyclable. As recycling opportunities develop, land filling will no longer be allowed, diverting wastes to more environmentally safe alternatives or reprocessing them into usable products.

## CLOSING THE LOOP

The phrase “Cradle to Grave” has often been used to encourage designers to consider the use of components of a building system once the component has fulfilled its useful life. Changing this phrase to “Cradle to Reincarnation” emphasizes the fact that products can be reincarnated into new (either higher or lower valued) products through recovery and recycling. For example, recovered old growth wood flooring carries a higher market value than new wood flooring. A key component in the overall waste reduction theme is following through with the entire concept beginning with the products life cycle through their use and disassembly.

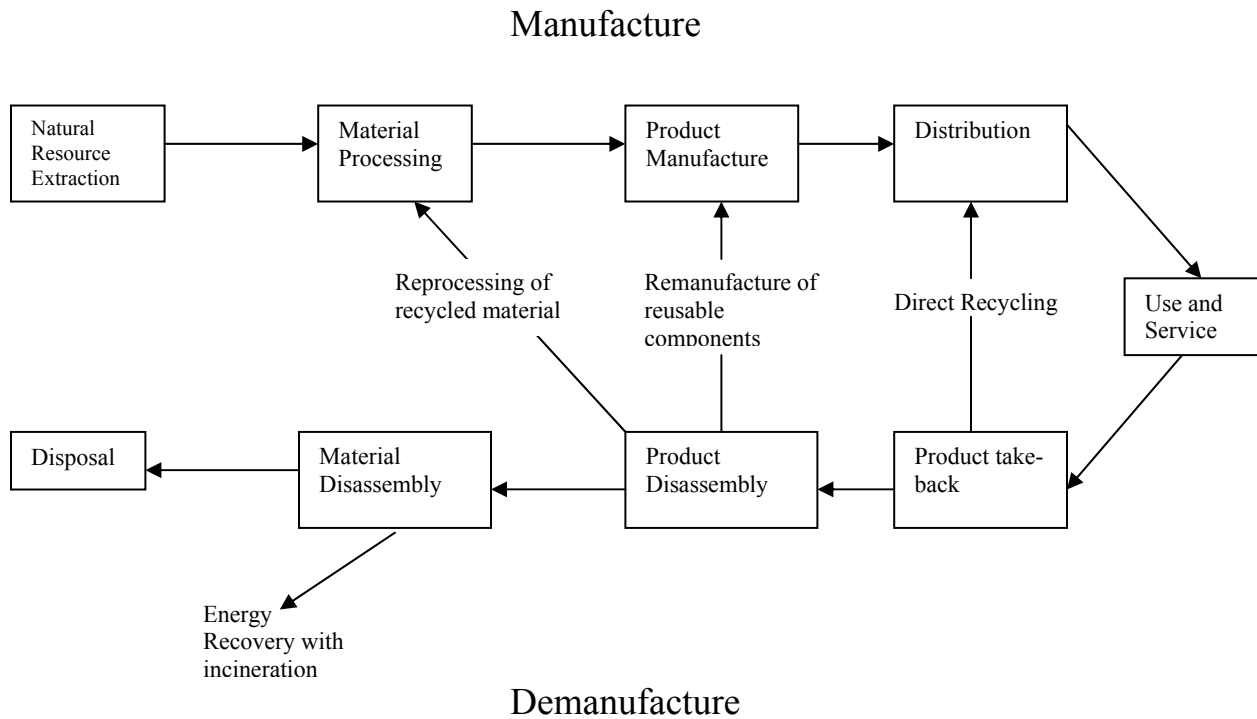


Figure 3: “Cradle to Reincarnation”

### **CASE STUDY:**

### **RECYCLED CONTENT IN CONSTRUCTION**

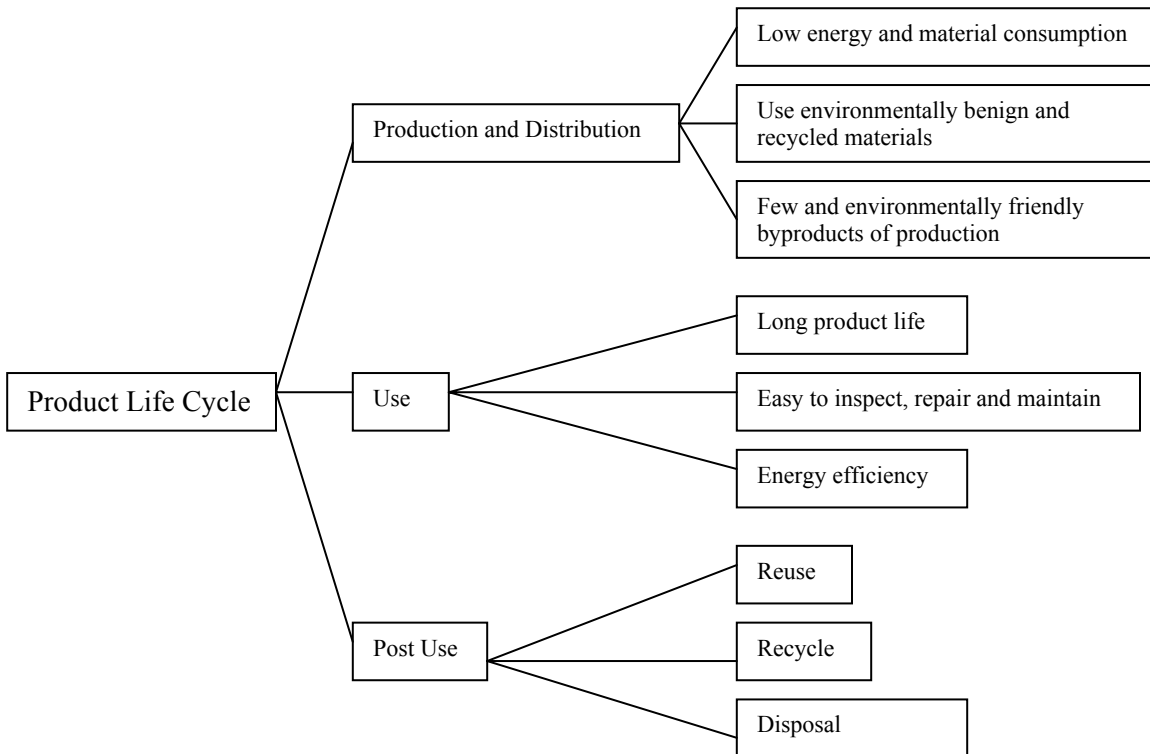
Two fast food restaurants have recently been built in western Washington, utilizing the latest recycled content building materials. These franchises, built by the McDonalds Corporation, feature extensive use of recycled content in both interior and exterior applications.

The McDonald’s Corporation has been active in utilizing recycled content products for several years and has recently extended these efforts to many of their construction related activities. To facilitate the sourcing of recycling content materials McDonald’s has developed the McREcycle USA Database, listing available materials. For products to be listed they must contain at least 10% recycled content and conform to standards for quality and competitive pricing.

**CASE STUDY: RECYCLED CONTENT IN CONSTRUCTION**

Use: New Residential Construction  
Size: 1,560 square feet  
Type: Slab on grade, advanced stick framing

Completed during a downturn in the real estate market, this home was the first to sell of all the homes in the subdivision, and generated substantial interest in subsequent project.



**Figure 4: Product Life Cycle**

**LIFE CYCLE ASSESSMENT**

Many market prices do not fully reflect the costs they inflict upon the environment. For example virtually no goods have the cost of disposal included, a few exceptions include deposits on bottles and advanced disposal fees on items such as tires. In order for a true cost of a product to be established a cradle to grave approach must be attempted. This method of costing a product is often referred to as life cycle assessment (LCA), it is defined as a, “Method to holistically evaluate the consequences associated with the cradle-to-grave life cycle of a product or process” (Makower 1994). Computing a LCA for a particular project is no easy task even simple products involve many steps to manufacture and dispose of. Tim Ream, an EPA environmental protection specialist, performed a simplified LCA for a bar of soap and identified no less than 30 different processes in the life of a bar of soap. In comparison, the difficulties involved with computing LCA’s for complex goods such as buildings would be nearly impossible. LCA’s are difficult to compute and implement, but consumers must be aware of all the costs associated with a good, in order to make environmentally sustainable decisions (Kibert and Guy).

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## **Florida Regulations Regarding C&D Waste**

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Currently, federal statutes and federal regulations governing solid waste do not differentiate between C&D waste and other municipal solid waste. This is likely to change in the near future. In the meantime, much of the legislation and regulation specifically addressing C&D waste exists at the state level and in local ordinances. Familiarity with relevant statutes, regulations, and ordinances is a necessity for all the players in the construction process.

### **TRADITIONAL DISPOSAL TECHNIQUES**

Traditionally, the contractor and various subcontractors on the site place most waste from construction and demolition sites into roll-off containers. These containers are removed from the site as the container fills up. Contractors do not often pay attention to where the material goes when it is taken off site. In Florida, Construction and demolition debris may be taken to any of the following facilities; landfills (Class III), Material Recovery Facilities (MRF's), or C&D debris facilities. **Although these are valid and currently inexpensive disposal options the point of advanced waste management is to avoid these alternatives whenever possible.** The key to reducing project disposal cost lies in reducing the waste generated and removing valuable material from these waste loads to be processed for recycling.

### **Landfills**

A large fraction of C&D debris generated in the U.S. ends up in landfills. Today the State has 35 active Class III landfills (FDEP, 2001). Class III landfills are those which receive only yard trash, construction and demolition debris, waste tires, asbestos, carpet, cardboard, paper, glass, plastic, furniture other than appliances, or other materials approved by the Department of Environmental Protection which are not expected to produce leachate. Leachate is created when solid waste is placed in an unlined landfill and the action of rainfall percolating through the waste migrates, ultimately coming in contact with the underlying soil and groundwater. If a hazardous chemical is present in the waste stream, it may "leach" from the land filled material into the leachate that is produced. Leachate contaminated groundwater will migrate away from the site resulting in the possible contamination of nearby groundwater wells. Processing at Class III landfills is typically limited to sorting and grinding C&D debris such as wood and concrete. As a result, these facilities do not recycle significant amounts of C&D waste. Most Class III landfills do not have major C&D debris processing equipment.

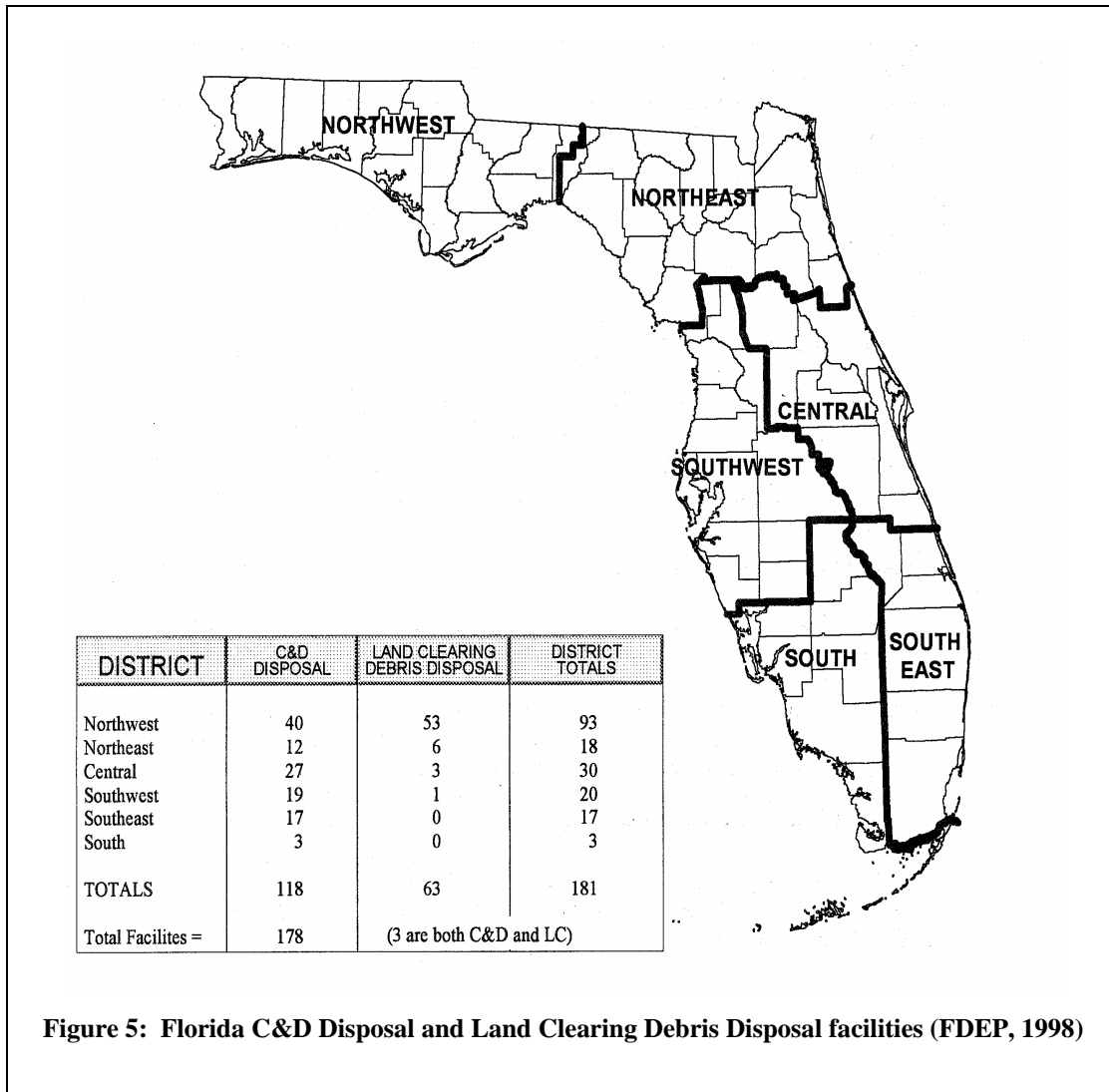
### **MRF's**

Florida has a total of 43 Material Recovery facilities (MRF's), and 137 Recovered Material Processing facilities (RMPF's). RMPF's process materials that have been cleaned by MRF's or collected directly from residential or commercial generators that have source separated recycled material. MRF's generally have a large assortment of capital-intensive processing equipment that grind, crush, shred, chip, sort, and bale recovered C&D debris. The state has 680 drop-off centers for materials to be recycled and 184 buy back centers (FDEP, 2001).

### **C&D Debris Facilities**

Florida has 181 C&D debris landfills where approximately 2.8 million tons were disposed in 1996 (FDEP, 2001). Prior to 1996, Florida had experienced a steady growth in the number of C&D facilities. In 1997, there has been a significant drop in the total number of permitted C&D

disposal facilities. This decrease in permitted C&D facilities is partially due to new and much more stringent C&D regulations. In addition to these landfills, the Department authorizes the use of Construction and Demolition Debris facilities. The state has 178 active C&D debris disposal facilities. Of these facilities, 118 are permitted as active C&D disposal facilities and 63 are permitted as land clearing facilities (FDEP, 2001).



**Figure 5: Florida C&D Disposal and Land Clearing Debris Disposal facilities (FDEP, 1998)**

### **INCENTIVES TO EXPLORING ALTERNATIVES TO DISPOSAL**

As alternatives to conventional C&D waste disposal are being considered, recognition of incentives is crucial. There are five primary incentives to exploring alternatives to disposal of C&D waste (Yost, 1999):

Cost Savings. As can be expected, every building, renovation, and demolition contractor would like to lower his or her total disposal costs.

Convenience. Many building, renovation, and demolition contractors consider more reliable or more convenient service as important if not more important than cost savings. A waste

management strategy that increases convenience or decreases the amount of time and energy that a contractor must spend on waste management is all the incentive needed to make the move from conventional disposal.

Liability. The building and demolition industries understand the long-term advantage that reduced liability provides. If a waste management alternative can be shown to reduce a company's legal exposure for waste they generate, this can be a strong incentive for considering an alternative to traditional practice.

Marketing. Greater distinction in the marketplace and increased business can be a strong incentive to construction and demolition firms to embrace new approaches to C&D waste management. The impact on business of targeted media attention or recognition from within the building profession, for good or bad activities, will be felt in any company's operations.

Social Responsibility. Construction and demolition industries are among the least progressive of businesses, but it would be hard to find many firms that prefer traditional disposal to the alternatives available. Waste reduction and recovery are often perceived and portrayed by workers as "the right thing to do" and, as an incentive for considering new approaches, social or environmental responsibility can be a powerful force for change.

### **Problems Associated with Altering Disposal Techniques**

- Overcoming the fear of change
- Recyclers are not always available in all markets
- Traditional waste disposal techniques in some areas are still relatively inexpensive
- Poor processing and marketing of recycled materials have hurt some alternatives
- Recycling is difficult and not cost effective for some materials

The key to a successful program is knowledge. Often besides combating attitude, there is also the fear of the unknown. By providing knowledge and needed information, this manual will aid in altering traditional techniques. It is necessary to know:

- The waste components
- The disposal options for each component.
- Need info about recycling service providers and material handlers
- Need financial and technical assistance to implement program

By the transfer of information and knowledge we can eliminate the misconception that recycling programs are too costly or require too much labor to implement.

### **Hazardous Waste**

The handling, storing and disposal of hazardous waste is governed by specific regulations. Efforts to reduce hazardous waste should be incorporated into any waste reduction plan. Hazardous waste created by general contractors consists of liquid sealers, paints, stains, and solvents.

### **ECONOMIC APPROACH**

There are three ways to approach the economic management of waste disposal.

1. **Take only those actions that save money** – since waste disposal is inexpensive in Florida, this option will result in few if any changes to traditional waste practices.
2. **Practice sound environmental waste management and spend no more money than you spend today** – a common misconception is that changing current waste management practices will result in an increase in project expenses. This is not the case, with proper planning, this will be a money saving alternative.
3. **Become an environmental leader and use your reputation in marketing your company** – this shows initiative in the construction market and is extremely beneficial in marketing and international markets. This can be the companies “ace in the hole” during project bids.

It is up to the company to decide their commitment level to environmentally sound waste management.

### **ECONOMIC BENEFIT**

The expense associated with waste disposal has long been accepted as a price of doing business in the construction industry. As land in Florida becomes scarcer, especially in south Florida, tipping costs continue to rise. New regulations have resulted in much stricter requirements for C&D disposal sites in Florida and are leading to an increase in tipping fees at these disposal sites. Consequentially, setting up an effective method NOW to minimize materials going to the landfill will continue to reduce your project bottom line cost over time. Builders, architects and engineers face increasing client demand for measures to reduce the bottom line cost of projects. Implementation of an advanced waste management plan will not only save money, but enhance your companies reputation. (See Section MARKETING)

Your construction company can save money two ways. First by reducing the amount of waste produced, and second, by reusing and recycling waste materials. Reducing the amount of waste produced both reduces your disposal costs and reduced the amount of raw materials you must purchase (commonly added by your estimators to your material order as “waste”). Reducing the volume of waste that ends up in dumpsters reduces the number of times you must pay for the dumpster to be hauled off site.

The potential cost savings associated with waste reduction and recycling opportunities vary depending upon the nature of each project and the project location. It is important to identify these local waste disposal alternatives.

**CASE STUDY: COMMERCIAL CONSTRUCTION PROJECT**

**Project Description:** 204,000 square foot, 3-story corporate office and manufacturing facility

**Current Waste Disposal:** 280 lcy (loose cubic yards) per month (\$13 per lcy)

**Current Recycling Program:** OCC (20 lcy per month)

**Savings:** \$140 per month

Potential Additional Waste reduction Programs and Estimated Savings:

Wood Recycling: \$160-\$250 per month

Pallet Exchange: \$312 per month

Metals Recycling: \$620-\$640 per month

**CASE STUDY: COMMERCIAL DEMOLITION PROJECT**

**Project Description:** Demolition of office building at Argonne National Lab Combination of wood frame, cinder block and corrugated metal construction

**Current Waste Disposal:** 113 cubic yards (ground down from 340 lcy)

**Current Recycling Program:**

Metals: 200 lcy (60 tons)

Aluminum: 3 lcy (250 lbs)

Concrete: 200 lcy (170 tons)

Paper: 7 lcy (1800 lbs)

Copper: 3 lcy (500 lbs)

**Current Waste Reduction Savings:** \$11,500

## MARKETING

As a company committed to waste reduction it is important to publicize your waste reduction efforts and positive results from recycling. Jobsite signage posted reporting your efforts is a great way to get noticed in the community. Most jobsites already have designated areas for company logos. It is relatively easy to add to these billboards, “We’re recycling on this jobsite – meaning less material ends up in the landfill,” or you can show a running total of the number of cubic yards of materials recycled as of a certain date.

- **What is Green Marketing?**

The majority of people believe that green marketing refers solely to the promotion or advertising of products with environmental characteristics. Terms like Phosphate Free, Recyclable, Refillable, Ozone Friendly, and Environmentally Friendly are some of the things consumers most often associate with green marketing. While these terms are green marketing claims, in general green marketing is much broader concept, one that can be applied to consumer goods, industrial goods and even services such as construction. Green marketing incorporates a broad range of activities, including product modification, changes to the production, packaging changes, as well as modifying advertising.

- **Why is Green Marketing Important?**

Answering the question of why Green Marketing is important is best defined by looking at the definition of Economics: Economics is the study of how people use their limited resources to try to satisfy unlimited wants. (McTaggart, Findlay and Parkin 1992, 24) Mankind has limited resources on the earth, with which she/he must attempt to provide for the worlds’ unlimited wants.

- **Why use Green Marketing?**

There are several reasons to use Green Marketing

1. Organizations perceive environmental marketing to be an opportunity that can be used to achieve its objectives (Keller 1987, Shearer 1990)
2. Organizations believe they have a moral obligation to be more socially responsible (Davis 1992, Freeman and Liedtka 1991)
3. Governmental bodies are forcing firms to become more responsible (NAAG 1990)
4. Competitors' environmental activities pressure firms to change their environmental marketing activities (NAAG 1990)
5. Cost factors associated with waste disposal, or reductions in material usage force firms to modify their behavior (Azzone and Manzini 1994)

### Opportunities

It appears that all types of consumers, both individual and industrial are becoming more concerned and aware about the natural environment. In a 1992 study of 16 countries, more than 50% of consumers in each country, other than Singapore, indicated they were concerned about the environment (Ottman 1993). A 1994 study in Australia found that 84.6% of the sample believed all individuals had a responsibility to care for the environment. A further 80% of the sample indicated that they had modified their behavior including their purchasing behavior due to environmental reasons (EPA-NSW 1994)

### Social Responsibility

Many firms are beginning to realize that they are members of the wider community and therefore must behave in an environmentally responsible fashion. This translates into firms that believe they must achieve environmental objectives as well as profit related objectives. This results in environmental issues being integrated into the firm's corporate culture. Firms in this situation can take two perspectives: 1) they can use the fact that they are environmentally responsible as a marketing tool: or 2) they can become responsible without promoting this fact.

### Governmental Pressure

As with all marketing related activities, governments want to "protect" consumers and society; this protection has significant green marketing implications. Governmental regulations relating to environmental marketing are designed to protect consumers in several ways, 1) reduce production of harmful goods or by-products, 2) modify consumer and industry's use and/or consumption of harmful good, or 3) ensure that all types of consumers have the ability to evaluate the environmental composition of goods.

### Competitive Pressure

Another major force in the environmental marketing area has been firms' desire to maintain their competitive position. In many cases firms observe competitors promoting their environmental behaviors and attempt to emulate this behavior. In some instances this competitive pressure has caused an entire industry to modify and thus reduce its detrimental environmental behavior.

### Cost or Profit Issues

Firms may also use green marketing in an attempt to address cost or profit related issues. When attempting to minimize waste, firms are often forced to re-examine their production process. In

these cases they often develop more effective production processes that not only reduce waste, but reduce the need for some raw materials. This serves as a double cost savings, since both waste and raw material are reduced. In other cases firms attempt to find end-of-pipe solutions, instead of minimizing waste. In these situations firms try to find markets or uses for their waste materials, where one firm's waste becomes another firm's input to production.

The last way in which cost or profit issues may affect firms' environmental marketing activities is that new industries may be developed. This can occur in two ways: 1) a firm develops a technology for reducing waste and sells it to other firms, or 2) a waste recycling or removal industry develops.

### Problems with Going Green

Firms using Green marketing must ensure that their activities are not misleading to the consumers or industry. In addition the firm must not breach any regulations or laws dealing with environmental marketing.

Green Marketing Claims must:

- Clearly state environmental benefits
- Explain environmental characteristics
- Explain how benefits are achieved
- Ensure comparative differences are justified
- Ensure negative factors are taken into consideration
- Only use meaningful terms and pictures

- What is Greening?

The word green or greening has come to mean energy efficiency, the environment and the green of dollar savings. This is achieved through the application of energy-efficient technologies and environmentally preferred or environmentally friendly products and practices in a multiyear, multidisciplinary project designed to improve energy efficiency, reduce waste, improve worker productivity, and save money throughout a facility. The goal is continued movement toward sustainability. Sustainability means meeting the needs of the present without compromising the needs of future generations.

## **Creating a Waste Management Plan**

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Achieving cost-efficient waste management on the construction project requires planning by the contractor. The contractor needs to plan waste activities, similar to planning a safety program, or general planning for the project. A plan prepares the contractor for opportunities, rather than encountering waste management as a daily problem. Planning is necessary to properly analyze alternatives, implement action, and evaluate the success of the program. The contractor's waste management plan should be a plan to minimize construction waste and waste disposal, utilizing conservation and recycling alternatives, while minimizing the cost incurred by such activities.

As regulations increase concerning waste disposal, some owners and regulatory agencies are requiring contractors to prepare construction waste management plans prior to the start of the project. These plans help the owners and regulatory agencies comply with solid waste goals, as well as serve the contractor as a blueprint for their waste management activities during the project. Your waste management plan will depend heavily on the specific project, the project location and the projects site as well as the company commitment to advanced waste management. Important questions when determining a waste management plan include:

- Do I have control over the design of the project?
- What waste will I produce (waste audit)?
- What is my site like?
- Can I recycle on site?
- Are there recyclers nearby?
- What are the landfill tipping fees?
- Contract Specifics?
- Training?

### **Waste Management Plans should address:**

1. Evaluate Projects Waste Reduction Potential
2. Identify and Implement Efficient Construction Techniques
3. Review Similar Projects
4. Brainstorm to determine Reduce, Reuse and Recycle Methods
5. Identify Target Materials (for recycling)
6. Identify Local Alternative Waste Disposal Options (i.e. recyclers, salvagers)
7. Compare rates and other factors and negotiate services
8. Finalize agreement
9. Finalize target material selection
10. Set waste reduction goals
11. Develop communications plan
12. Develop Motivational Plan
13. Develop Evaluation Plan
14. Ensure Subcontractor Commitment
15. Contract Structures
16. Assign Individuals
17. Establish Contacts
18. Education (Workforce Acceptance)
19. Evaluating Strategies

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## **Changing Traditional Practices**

### **KEYS TO A SUCCESSFUL WASTE MANAGEMENT EFFORT**

Above all, be practical. There may be no feasible way to implement these strategies in the local of certain projects. Start slowly and increase the company's effort as the learning curve for advanced waste management improves.

#### **Waste Audit** (SEE SECTION WASTE AUDIT)

Waste Audits (Waste Stream Analysis) provide a clear starting point for evaluating the waste projects generally create during construction, renovation, and demolition provides a starting point in establishing a beneficial program. There are two methods that may be employed to complete waste audits; 1) perform audits on site using existing personnel, or 2) hire a consultant.

#### **Project Specific Information**

Each construction project and job site is unique and presents a different set of circumstances. Steps taken to reduce waste must be specific to each project to maximize the benefits

#### **Identify Local Waste Disposal Options**

Understanding available disposal options and limiting factors (such as a lack of local recyclers or low tipping fees) in the projects locale will aide in creating a waste reduction plan for the project. It is necessary to identify available collection, sorting, and recycling services and variables about a specific project that could limit or constrain the waste reduction effort.

#### **Focus on high potential materials and practices**

Target waste materials that are generated in the most volume and have the highest market value for waste reduction or recycling. If the company commitment is minimal select one material and focus the companies efforts on that material.

#### **Committed key field personnel**

This requires the involvement of both management and field personnel and should be done at the startup of a project or when a new subcontractor, supplier, or other field personnel join the project. Altering traditional waste disposal will only be effective if key field personnel understand and are committed to the program.

#### **Convenience**

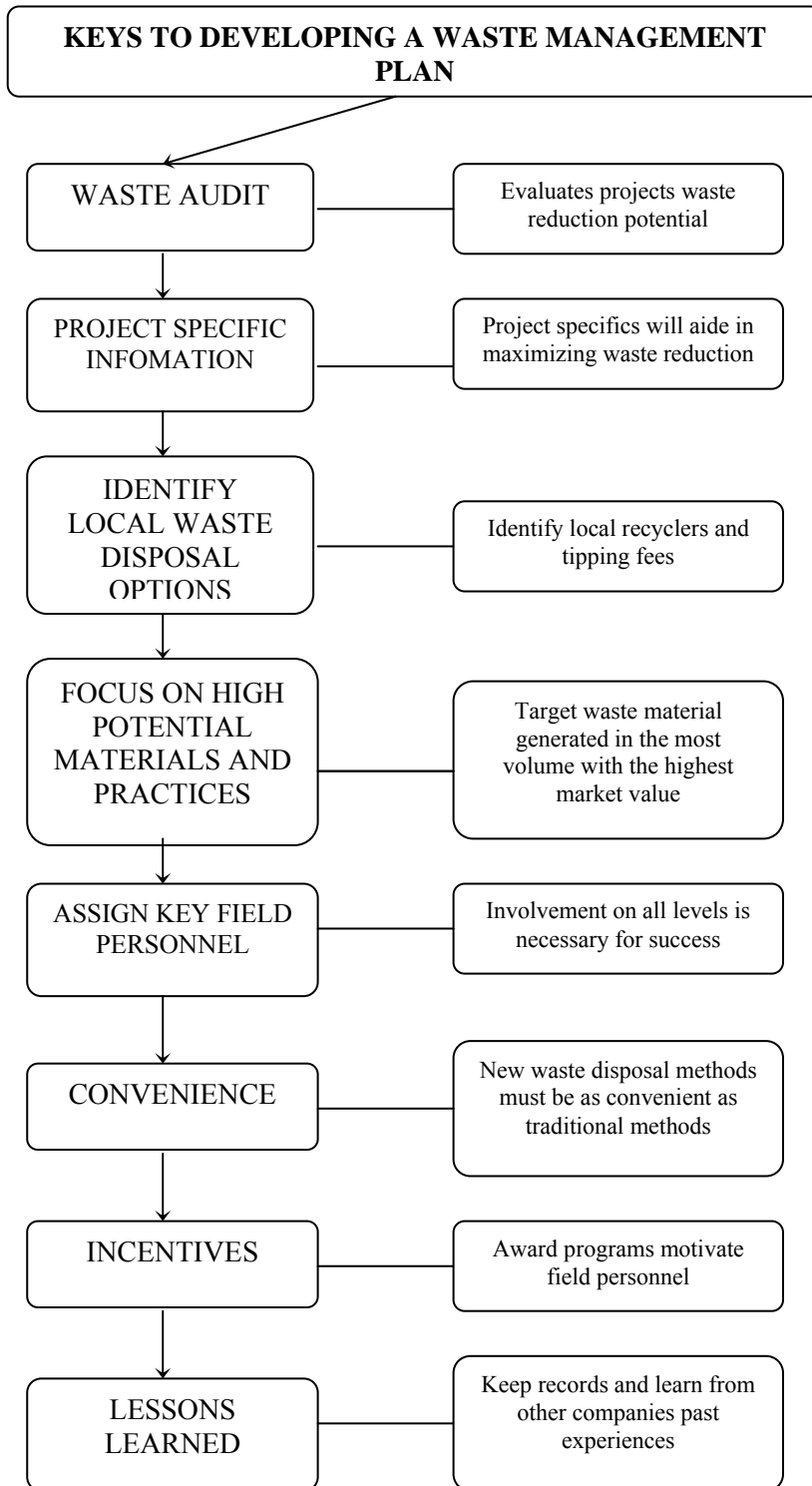
It is important to make Reducing, Reusing, and Recycling as convenient and efficient as traditional methods of waste management. Simple measures, such as correct placement and clear labeling of recycling bins, can make or break a waste reduction program.

#### **Offer incentives**

Award programs and other incentives motivate field personnel and will aide in a successful waste reduction, recycling and reuse program.

#### **Use Lessons Learned**

It is important to gather information from other companies who have implemented waste reduction strategies. Keep records indicating quantities of waste reduced and project savings to evaluate and improve the waste reduction program.



**Figure 6: Keys to Developing a Waste Management Plan**

In order to determine the best course of action for your company on a specific project you must first collect information your company's waste stream. Although every project is different, the types of waste created from construction activities remains fairly constant. For example, both new commercial construction and demolition will produce concrete waste, however the amount of concrete waste created from demolition will by far be greater than that during new construction.

Sample Waste Audit Forms are provided in the appendix of this manual.

### **WASTE STREAM ANALYSIS – Collecting the Data**

A waste stream analysis will determine what type of materials are being placed in your waste containers, how much of these materials are being disposed of, and the potential value of these materials in the recycling market.

There are two methods of performing a waste stream analysis. The first involves collecting actual numbers from project sites to determine what types materials are being discarded and in what quantities. The second is to rely on previous experience and past project information. In either instance knowing what materials the project can create in excess identifies potential waste reduction options.

### **Types of Waste Stream Analysis**

1. Reviewing purchasing records for information such as products that could be purchased with recycled content and the amount spent annually on single use items that could be replaced with reusable alternatives
2. Conducting a facility walk through, which can reveal important information on operations such as the extent of current recycling and waste prevention practices.
3. Performing a limited or facility wide waste sort to provide detailed information on the individual components of a facility's waste.
4. Use waste audit forms (that follow) that follow to analyze actual waste produced.

## **WASTE ASSESSMENTS – Analyze the Data**

Waste Assessments are necessary to analyze the information collected in the waste audit. The assessment should provide the following information:

- Type of waste generated
- How this waste is generated
- How much of each type of waste is generated
- Ideas on how costs can be reduced by implementing specific waste reduction actions.

The waste assessment is the beginning of a value engineering process. Once all the facts and data is presented, (waste audit) this information may be processed and analyzed to determine a plan of action. Brainstorming will allow for creative solutions and potential waste reduction ideas and strategies to be introduced. This information is valuable in choosing the most feasible and cost effective actions and in determining what changes in purchasing practices or operations are necessary to successfully implement each action.

Once the waste analysis is complete, the company may evaluate and identify:

- Waste reduction opportunities
- Specific construction operations or processes that produce excess waste
- Potential waste reduction strategies
- Operational and economic feasibility for promising options

After completing a waste stream analysis and assessing the project specific waste stream, and effective and usable waste management plan is necessary. With the high volume waste materials identified it is easier to target specific construction process and techniques for waste reduction. At this point it is also important to introduce the cost associated with both the purchase and disposal of these waste materials. The entire construction process may be value engineered to determine the best and most cost effective actions that will result in waste reduction.

### **Recommendations**

#### **For Project Managers**

- Understanding who is producing the majority of the waste created allows you to target those subs for review.
- Assist subs in identifying reduction options

#### **For Contractors and Subs**

- Waste assessments help establish a better understanding of current purchasing, waste generation, and waste disposal practices.
- Assessments identify potential waste reduction options for evaluation
- Establish a baseline from which to measure the success of the waste reduction program

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## **Waste Disposal Based on Firm Type**

Depending upon your ability to affect the project, you have various options available to you to change the waste situation you are facing. It is important to realize that each project is unique and presents any number of variations in waste stream make-up and alternative disposal strategies, however existing plans can be utilized as reference points. Implementing successful waste management strategies involves a clear understanding of available options and cooperation in executing should be the intentions of all the trades people involved.

### **Architect / Design**

The importance of the Architect/Designer should not be overlooked in the waste reduction effort. One of the first steps in reducing the amount spent on waste disposal is to reduce the amount of waste produced or created. You can save money by reducing the amount of waste created. The initial step in a construction waste reduction strategy is good planning. Design should be based on standard sizes and materials should be ordered accurately. Additionally, using high quality materials such as engineered products reduces rejects. This approach can reduce the amount of material needing to be recycled and bolster profitability and economy for the builder and customer. Design for reuse and recycling. Design choices will ultimately create demand with manufacturers to increase research and development in recycled content materials and increased use of recycling in the production of materials.

### **Owner**

Since the owner is the party that ultimately must be satisfied, it is also the owner that may demand advanced waste management. Most often this is in the form of recycling, simply because recycling is a known technique. However, it is also important that the owner be aware of all levels of the waste management hierarchy to optimize the resources utilized on construction projects.

### **Construction Management**

Construction managers are in a unique position that lends itself to optimizing all waste reduction possibilities. The construction managers work with the owners designers and subcontractors intimately and therefore can influence waste creation and disposal throughout the project duration. At this stage specific waste management specifications can be worked into projects prior to the bidding process.

### **Project Manager / General Contractor**

The project managers or general contractors will ultimately be in charge of implementing all site-specific procedures. The project managers will control site set up, layout, and is responsible for the subcontractors and site. The PM's responsibility is not only implementation, but also enforcement.

### **Developer**

The developer also has an obligation to practice sustainable principles. Often, the developer is in control of large commercial areas of development or tract housing projects that are made-up of many multiple-units of similar design. There is tremendous opportunity in targeting materials in these large developments.

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## **Reduction**

The best way to manage your waste is not to create it at all. Waste reduction is the most economical alternative to disposal for any material type. Implementing source reduction is often complicated by the fact that much of the design and construction community is just beginning to recognize that they have a role in creating source reduction solutions. Providing such solutions will ultimately improve the final product and achieve business goals. It is necessary to identify available options and the impact of these options on the design and construction process.

Job site reduction efforts can often achieve: a reduction in expenditures for materials because less material is necessary; lower labor costs because less material must be handled and cut; and a decrease in disposal costs because less material must be transported to the landfill.

### **Keys to Job Site Reduction**

- Avoid damage by handling and storing materials properly
- Avoid mixing recyclables and non-recyclables
- Use materials efficiently and use less of them
- Estimate as accurately as possible; more accurate = less waste
- Purchase precut and prefab components
- Choose strong materials and exploit structural advantages
- Purchase high-grade materials
- Reduce packaging waste
- Coordinate just-in-time deliveries
- Reduce the use of non-recyclable materials
- Replace disposable materials and products with reusable materials and products

### **RESOURCE OPTIMIZATION**

Resource optimization has been going on in other industries religiously for years. Better, Smarter, Faster is a common motto for large industries attempting to increase their profit. Clarify your goals and how they might affect your project. For example, set a goal of reducing the total amount of structural materials used by 10%. Work with your design team and explain the purpose of this goal and the effects it will have on the project. Giving the design team an explanation will often generate creative source reduction solutions and convince others to support your efforts in implementation. Clear and effective communication has proven to be a critical step in implementing source reduction.

### **REDUCING FRAMING WASTE (RESIDENTIAL)**

For most homebuilders, framing lumber represents one of the largest volumes of materials purchased and the largest component of the waste stream. Designing and framing a house efficiently can not only reduce the required amount of material, but can also decrease disposal costs by keeping excess cutoffs to a minimum.

Efforts to reduce waste in such projects must be addressed during several phases, including design, engineering, estimating, and framing. The National Association of Home Builders (NAHB) recommends following these techniques for potentially significant savings (Yost & Lund, 1996):

- In-line framing of trusses, studs, and joists to efficiently transfer loads
- Modular house configuration and modestly sloped roof design
- Slab-on-grade foundations
- Eliminate excessive waste factors when doing take-offs
- Use detailed construction drawings for accurate material estimates
- Separate reusable lumber on the jobsite for use as blocking, bridging, and nailers
- Reduce header size where feasible
- Relocating doors, windows, and stairs to coincide with modular studs
- Consider alternate corner details

### **TAKE BACK POLICIES**

The most efficient way to handle the recovery of some building material waste may be for the supplier or even the manufacturer to take back clean, separated waste. The key to the take-back approach is to backhaul materials, thereby eliminating transportation costs. Take-back and backhaul policies may work for everything from cardboard to drywall to vinyl siding.

### **SUPPLIER REDUCTION OF PACKAGING MATERIALS**

Ask local suppliers to take back their packaging, or to package in a manner in which less material is used. This often is a benefit to both the supplier, who spends less money on packaging, as well as a benefit to the builder who spends less money on the disposal of the packaging.

### **WORKER COMPLIANCE**

Provide reminders at safety or other regular meetings of the project's waste reduction goals. Use these meetings to report progress, discuss problems, and discuss specific actions that can be taken. Site Success in developing a waste reduction plan depends on a company's ability to implement an effective labor force to carry out the effort. One cannot expect a laborer, carpenter, or mason to simply adopt a waste management culture on his or her own.

Including waste handling requirements in all project documents. This makes it clear from the beginning that waste reduction, reuse, and recycling is expected from all crew members. Create a name or slogan for the waste management effort that is going to be employed. Inexpensive rewards such as hats, T-shirts, or decals can provide incentives for worker compliance. Management must be positive and share the success, letting crews know how effective they have been by regularly posting the volumes of materials reduced, reused, or recycled. It is also important to include everyone in the process, encouraging suggestions for more efficient methods.

### **DIRECT REUSE**

Direct reuse through product recycling incorporates the removal and immediate reuse of used building components. This has one of the highest priorities from an environmental point of view. Direct reuse allows all of the resources such as the raw materials and energy that were put into the product during its original manufacturing to be preserved. A disadvantage of immediate reuse is that reuse requires non-destructive disassembly and additional inspection operations, which may increase cost. Many areas have contractor surplus exchanges, which offer connections between contractors looking for supplies and those having excess.

Used building materials can be redeployed in a new setting at the job site, or at subsequent jobsites. Building materials removed during the renovation process have the greatest potential for reuse. These include cabinetry, doors, windows, plumbing fixtures, electrical fixtures, wood flooring, and large dimension framing.

#### **Keys to a Successful Job Site Reuse Effort**

- Use salvaged materials from other jobs
- Reuse jobsite materials such as concrete forms and fencing
- Use methods for construction temporary structures that allow for reuse, such as screws rather than nails
- Use a central area for cutting and storage of scraps for reuse
- Allow for local scavenging, if not a site safety issue
- Donate or sell reusable items from the job
- Avoid throw-away equipment

### **BUILDING MATERIALS REUSE CENTERS**

Reuse centers accept and then resell used, salvaged materials and misordered or slightly damaged new materials. Materials come from building material retailers and manufacturers, remodelers, and new builders. Many reuse operations are not-for profit organizations. Donors can take tax deductions, reduce their disposal cost, and enhance their corporate image. For profit facilities, on the other hand, buy at reduced margins, or collect materials that otherwise would be taken to the closest landfill.

### **SUPPLIER RETURN POLICY**

Many suppliers will take back their own materials for recycling into new products. This benefit sometimes is only available to high volume clients and may be limited to specific products and locations. (Items such as drywall, vinyl, carpet and carpet padding may be returned) Where feasible, these wastes along with salvaged and unused materials can be put into “reverse distribution,” back to the manufacturer. This process requires cooperation among the builder, owner, distributor, and manufacturer, as well as an economic distance between the job site and manufacturing plant.

## DECONSTRUCTION

Deconstruction is a new process that can be described as construction in reverse. It involves carefully dismantling a building to maximize reuse of materials, thereby reducing waste and conserving resources. In comparison, traditional demolition generally uses a wrecking ball or dynamite to destroy a structure and reduce it to rubble, which is then carted to a landfill.

Architectural elements, windows, doors, and metals may be salvaged before this process begins, but wood flooring, brick walls, and structural timbers usually end up in the rubble. While no data are available on the percentage of C&D waste that is generated in the demolition phase, experts put it at about 50 percent of the total.

Demolition projects offer the perfect opportunity to take advantage of the second and third levels of the waste management hierarchy, Reuse and Recycle. Disposal costs represent a far larger part of operating costs for demolition activities. It is estimated that over 70 pounds of waste is generated for every square foot of residential demolition. As a result, waste reduction measures during demolition could represent significant savings and be a great incentive to recycle. Source separating materials at a demolition operation site is more difficult than at construction sites due to commingling of materials.

### **Keys to a Successful Demolition/Deconstruction Effort**

- Conduct detailed assessments
- Characterize buildings and inventory salvageable materials, obtain information from designer about building
- Determine the volume and value of salvageable materials
- Estimate labor hours to dismantle building and access salvageable materials
- Identify problem areas: Asbestos, lead-based paint, treated wood
- Select the optimum contracting method
- Include requirements for job training

Deconstruction versus demolition can result in significant cost savings. Many valuable materials often remain in buildings scheduled for demolition. Salvaged materials may be used for building renovation or in a new building that is erected in place of the demolished structure. These salvaged materials may also be sold to material reuse centers. It is also possible to contract out the salvaging operation to companies specializing in removing materials.

### Cost Considerations

- Financial feasibility of deconstructing a building
- Amount and value of salvageable materials
- Structural complexity and accessibility of salvageable materials
- Amount of debris not able to be reused or recycled
- Excellent candidates: Warehouses and industrial buildings
- Variable Candidates: Offices and Housing

### Economic Factors

- New businesses based on deconstruction and reuse activities
- Used Building Materials Association
- Re-Use Inc. and Community Distribution Centers
- Reduced cost of demolition for construction industry: reduced capital costs and landfill dumping charges
- New business infrastructure

### Social Factors

- Job creation
- Ratio of 10 resource recovery jobs to 1 landfill job
- Job training for low-skill individuals working under supervision of experienced contractors
- Training of workforce for new industry
- Shortage of training grounds for worker in construction industry
- Local Economic Development
- New Activities: Deconstruction, storage, sorting, transporting, recycling, remanufacturing, and resale
- Growth rate: 15-20% per year in locales where implemented

### Environmental Factors

- Decreased reliance on scarce landfill space
- Lowered impacts on environment
- Preserving Virgin resources
- Helps comply with laws to reduce solid waste stream

### Recommendations / Strategy

- Develop a strategic plan that includes all buildings
- Avoid cherry picking to reduce overall costs
- Institute deconstruction as soon as possible
- Conduct workshops to develop a local strategy
- Strategic combination of deconstruction and demolition
- Group buildings in packages to reduce cost

Recycling is the most common or well-known alternative. Local markets are slowly developing as the cost to dispose of waste increases. Recycling is often preferred since destructive disassembly may be used. Recycling efforts on the jobsite can take a number of different approaches, each of which has its own set of options. The approaches readily available to contractors include:

- Hiring a full-service recycling contractor
- Using the garbage hauler's recycling service
- Implementing an in-house recycling program
- Making subcontractors responsible for recycling the waste they generate

Often there is some additional cost associated with recycling construction material until an established procedure is developed. Cost savings can be realized with donations to non-profit organizations that specialize in construction waste recycling resulting in tax deductions. Cost savings are also realized through the efficient design and use of materials minimizing waste. However, transportation costs and the lack of local companies using recycled resources make recycling of many materials that are not directly reusable too expensive to be feasible at the present time.

### **Keys to a Successful Job Site Recycling Effort**

- Management Support
- Team, PIC (person in charge)
- Knowledge of Waste Stream
- Setting Goals
- Finding Markets
- Selling Material Collected
- Collection and Suitable Storage of Recyclables
- Education and Motivation
- Monitoring and Evaluation

## **WHAT IS RECYCLABLE**

The extent to which a recycling effort can be taken depends largely on the local markets for recycled C&D waste. There are certain materials that can be recycled on most projects, such as cardboard, clean dimensional lumber, land clearing debris, concrete, bricks, masonry units, asphalt, and metal. Additional materials for which markets exist in some areas include drywall, plastic buckets, plastic sheeting, carpet and carpet pad, paint, asphalt roofing shingles, vinyl siding trim, and rigid insulation. Estimates are that up to 90% of C&D waste is potentially reusable or recyclable, depending upon the type of project and local markets for waste materials.

## **MIXED MATERIALS COLLECTION (COMMINGLED RECOVERY)**

This method allows the collection of targeted recyclable materials in one container while materials that are not to be recycled are collected and disposed of using conventional waste management techniques.

Advantages: With mixed material collection there is no need for many separate collection containers that may clutter a space-constrained site. There is also minimal effort required by laborers, making this an effective alternative. This option involves little to no builder involvement.

Disadvantages: Include the loss of potential revenue from recycling potentially valuable materials such as scrap metal. There is one price associated with the filled container regardless of the value of its contents.

This method is similar to conventional disposal techniques; however, the waste is brought to a MRF at which time it is mechanically or manually separated. These processing facilities typically compete with local landfills and therefore offer competitive tipping fees to the waste hauler.

### **JOB SITE SOURCE SEPARATION**

This is a method in which each target recyclable material is separated from the waste stream and placed in its own container for collection by a recycling service provider. At the beginning of each job, bins or other means of containment should be set up to hold each of the materials targeted for recycling. This is a good option if you have adequate space on site.

Advantages: Separation of materials on a job site provides a specific, clean waste stream that can be directly sold to recyclers. Selling each individual material will allow the highest market price (revenue to the company) to be achieved. This program can be highly visible to the general and buying public, which produces market exposure for the builder and subcontractors. Job site source separation will save on disposal costs and potentially generate income through the sale of recovered material.

Disadvantages: One disadvantage lies in the need for multiple containers on site, additional labor required to separate and properly discard the materials. This method also works only when the builder and subcontractors keep the loads clean and separated and the hauler provides prompt container service. For this method to be successful, the compliance of subcontractors is required to avoid contamination. To maximize the disposal cost savings, the additional labor requirements must be minimized by planning a source separation strategy and locating local processors that will meet your needs.

### **TIME-BASED SEPARATION**

Time-based separation is a variation on source separation that coincides with specific stages of construction. The hauler is able to take advantage of the fact that on residential and smaller commercial projects, only one major type of waste is produced during each phase of construction.

Advantages: Since different materials are created in large quantities at varying stages throughout the construction process fewer containers are needed on site. During any given time, only a few select materials are being targeted for recycling. The reduced need for space for multiple bins makes this strategy attractive for urban infill projects.

Disadvantages: A possible disadvantage is that if crews are not contributing to job site recycling, they are less likely to factor waste prevention into their construction practices.

### **SELF SEPARATION / SELF HAULING**

In this option, the builder sorts and transports all materials. Requires a strict commitment in terms of time, effort, and information gathering; knowledge of local recycling sites, and causes wear and tear on transport vehicles. Builders large enough to dedicate a crew and equipment to full-time waste management or small enough to make waste management an integral part of daily business trips are best suited to self-hauling. Cost-effective self-hauling requires detailed information on distances to outlets and landfills, outlet and landfill policies, and vehicle and personnel costs.

### **CLEAN-UP SERVICES**

Hiring a Clean-up Service takes the burden of waste management out of your hands. These services provide waste management tailored to meet the needs of each builder. Instead of using large site containers, all construction waste designated for recycling is placed in a designated area on the site surrounded by plastic fencing or stakes to create a containment area. A work crew visits the site at specified stages during the construction process. By timing their visits according to construction activities, less sorting is required of the waste to take advantage of recycling operations existing in the area. The burden of locating local recyclers is placed on the clean-up service.

#### **CASE STUDY:**

#### **CLEAN IT UP MARK!**

Run by Mark McGregor out of Portland Oregon, “Clean It Up Mark!” works with builders and developers, handling their site clean-up and waste hauling. Clean It Up Mark! separates and hauls materials from the job-site on a time-based recovery approach. Typically, job-site visits coincide with the completion of each major stage of construction. The first time the Clean It Up Mark! crew goes to the site may be when the framing is complete and the piles of debris consist of lumber stock and sheathing off-cuts. The second visit is when the outer skin of the building is complete and the waste is mostly roofing, siding, and painting debris. The last visit will pick up the cardboard, carpet, and trim scraps associated with interior work. Gypsum wallboard is normally handled separately by the drywall contractor. The majority of the materials McGregor recycles are untreated solid wood and engineered wood products.

Offered as a package based on the square footage of a building, Clean It Up Mark! is attractive to general contractors because the cost is agreed upon before the job commences, and the builder may save up to 25% in disposal costs. McGregor is able to take advantage of the fact that old-fashioned waste haulers charge by volume at the job-site, while the landfill charges by weight. By finding a less costly recycling outlet for heavy materials such as wood, additional money is saved when land filling any leftovers that are not recyclable such as miscellaneous plastics and composites.

Clean It Up Mark! is an innovative and successful service for small-scale builders and developers in Portland and serves as an example for other areas with high landfill charges. However, it is a service geared to a particular segment of the building industry, and larger-scale projects or regions with minimal recycling opportunities require different solutions.

## END-MARKETS

End-markets are the components in the recycling process that actually drive recycling programs. Without end-markets, recyclable materials would never get processed into new products, and would end up in a landfill. Recycle-content material end-markets vary for different types of recyclable materials.

### Possible End-Markets for Different Types of Recyclable C&D Materials

- **Wood** - wood fuel, mulch, bulking agents for composting, manufactured wood products, alternative wood fiber-based materials (e.g., particle board, door panels for cars, cement additives)
- **Metal** - reuse by salvagers, various metal feed stocks
- **Glass** - reuse of windows and mirrors, inert granular material additive, fiberglass, reflective beads, glasphalt
- **Concrete** - Road base, fill material, aggregate for new ready-mix, lime for a neutralizing agent, riprap for harbors (large pieces)
- **Asphalt Pavement** - asphalt patch for roads (cold-mix), on-site processing into hot-mix for roads, road base or fill material
- **OCC** - paper fiber feedstock
- **Drywall** - soil amendment (gypsum), cement additive (gypsum), new drywall (gypsum), paper fiber feedstock (paper), animal bedding (paper)
- **Asphalt Roofing** - asphalt patch for roads
- **Rubble** - aggregate for fill or road base, construction entrance roads, drainage bed material, landfill cover material

## RECYCLED CONTENT PRODUCTS

Recycled-content building materials are just like building materials made from virgin materials; they help conserve our natural resources and support the end-markets for recyclable materials in your area. There are already many building products available today that are manufactured from recycled materials. For example, organic asphalt shingles contain recycled paper, and some shingles are made from re-manufactured wood fiber. Cellulose insulation is manufactured from recycled newspaper. New products utilizing recycled materials, such as carpet, concrete, and plastic lumber are currently being developed

Alternative building technologies can conserve resources as well. Technologies that allow more efficient use of lumber include stress-skin panels; engineered framing products, such as I-beams, glue-laminated products, and finger-jointed lumber. These products allow for the use of "scrap" lumber that might otherwise be land filled, as well as the use of small-dimension lumber.

### Postconsumer vs. Preconsumer

Postconsumer recycled-content products contain materials that have been used by consumers, such as a contractor, and collected for reprocessing.

Preconsumer or postindustrial recycled-content products contain waste materials created as a by-product of manufacturing that are collected and reincorporated into the manufactured product.

Products with high postconsumer recycled content are more resource efficient. However, using a product with any recycled content is better than using products made entirely with virgin materials that consume more energy and natural resources.

### **Benefits of Buying Recycled Content Products**

Quality. Today's recycled-content building materials are competitive in price with high quality and durability. Many ASTM and UL certified materials are available.

Resource Efficiency. Recycled-content building products can be manufactured using recycled construction wastes, offering a closed-loop recycling opportunity. These products also create needed markets for recycled materials, reducing the strain of consumption.

#### **CASE STUDY:**

#### **RECYCLING IN CONSTRUCTION**

**Project Description:** Battendorf, Iowa Interactive arts and sciences museum exhibit construction

**Waste Impact:** Waste materials comprised of twelve tons of wallboard and 120 cubic yards of corrugated cardboard were recycled during construction. Through the use of recycled PET carpeting, 38,250 plastic soda bottles were kept out of a landfill. Wainscoting on the main floor was made from wood from a certified forest. Nine recycled content products were successfully substituted for conventional materials late into the project.

The Family Museum incorporated recycled content materials in its construction to demonstrate the necessity and feasibility of closing the recycling loop. The Family Museum particularly wished to emphasize that the use of recycled content materials is possible even during the late stages of a construction project. The staff of the Iowa Department of Natural Resources Waste Management Assistance Division awards grants to proposed projects that meet their criteria for encouraging the reduction of materials going to landfills. Projects can either encourage recycling, waste reduction, or the purchase of recycled content products. Through the Landfill Alternatives Financial Assistance Program, the City of Bettendorf was given \$75,000 to fund the purchase of recycled content materials for constructing the Family Museum.

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## **Material Specific Suggestions**

All of the major components of the C&D waste stream have potential for better management practices by incorporating the reduce, reuse, recycle approach. Listed here are a few material specific suggestions that may be implemented during the planning and construction stages of a project.

### **SITE / LANDCLEARING**

#### **Planning**

- Use asphalt paving with recycled content
- Use concrete mix containing fly ash as part of the cementations content of the concrete

#### **On-Site**

- Separate and recycle asphalt and concrete
- Sell all marketable trees designated for removal. Grind, chip or shred other vegetation for mulching, composting.
- Separate stumps, brush and other wood waste for recycling
- Separate and recycle rebar and other metals
- Reuse removed crushed concrete and asphalt as aggregate, sub-base material or fill
- When remodeling older buildings, save finishes such as bricks to match remaining finish or preserve an antique brick look
- Provide on site locations for as much excavated rock, soil and vegetation as possible

### **WOOD**

#### **Planning**

- To reduce waste and cost, accurately order the amount of material needed
- Use salvaged building materials
- Try new building systems such as modular systems or foam-core panels that minimize the use of wood.

#### **On-Site**

- Separate and recycle wood
- Make sure both interior containers and exterior recycling dumpsters are convenient and clearly labeled
- Store materials so they are not damaged
- Measure carefully to avoid end cuts
- Save sizable pieces of wood in a central area for use as spares, blocking, kindling or for use on another job.
- Designate a central area for end-cuts and damaged wood, making it convenient for carpenters to find and use scrap wood.

## **CONCRETE**

### Planning

- Accurately estimate quantities of materials needed when ordering and lower waste factors when performing take-offs
- Specify take-back policies for concrete suppliers when feasible
- Locate local processing/crushing plants

### On-Site

- Double-check accuracy of formwork erection to help reduce amount of rework/repouring
- Utilize excess concrete brought to site for parking stops, gutters, mailbox anchors, etc.
- Crush into rubble with mobile grinding unit and use as sub-base, fill, or drainage medium
- Separate and store unused portions of reinforcing bar, and perform all cutting, shaping, and tying in a central location
- Sell rebar for scrap or use it on another job

## **MECHANICAL, ELECTRICAL, AND PLUMBING**

### Planning

- Order mechanical, electrical, and plumbing supplies with recycled content
- To reduce waste and cost, accurately order the amount of material needed
- Ask vendors and suppliers to reduce the amount of packaging (pallets, cardboard, plastic shrink-wrap, metal bands) that are delivered to the job-site.
- Ask the vendor to take non recyclable packaging back for reuse

### On-Site

- Retain PVC cut-offs for use as stubs for wall drains
- Properly clean joints to prevent leaking
- Separate and recycle cardboard
- Separate and recycle plastic (including PVC if possible), metals, and adhesives.
- Make sure both interior containers and exterior recycling dumpsters are convenient and clearly labeled
- Store materials so they are not damaged
- Measure carefully to avoid end cuts

## **DRYWALL**

### Planning

- Order drywall with recycled content gypsum (commonly available from Domtar and USG)
- To reduce waste and your costs, accurately order the amount of materials needed
- To encourage efficient use of materials, avoid paying installers based on sheets of material installed, use square foot installed

### On-Site

- Store materials so they are not damaged
- Measure carefully to avoid end cuts

- Separate and recycle waste drywall
- Make sure both interior containers and exterior recycling dumpsters are convenient and clearly labeled
- Store materials so they are not damaged
- Save sizable pieces of drywall for use around doors, windows, or built-ins or for reuse on another job

## **MASONRY**

### Planning

- To reduce waste and cost, accurately order the amount of material needed. This starts with improved take-offs
- Use salvaged building materials

### On-Site

- Store materials so they are not damaged – whole blocks or bricks should be stored in a central location
- During site clean-ups separate loose masonry into a centralized pile or bin
- Combine half skids of brick and block, and half boxes of tile. Skids or boxes that are less than half full are often discarded
- Leftover materials from one site can be reused on another site
- May be crushed on site and used for fill or as bedding material for driveways

## **CARDBOARD**

### Planning

- Purchase articles in bulk containers when possible
- Specify in purchase orders that suppliers / vendors deliver goods with a minimum amount of packaging

### On-Site

- The paper, cardboard, and metal packaging that the building materials and major appliances come in should also be separated and stored. There are well established markets for these materials that could both generate income and reduce disposal costs
- Bundle the cardboard to permit easier storage, and deliver to a recycling facility
- A large number of recycling companies will remove cardboard wastes, if quantities justify. Some companies will provide storage bins to the site.

## **PALLETS**

### General

- Ask vendors and suppliers to take pallets away after delivery.
- Store pallets in a central location – often a delivery person will be more than glad to claim abandon pallets that are in good shape for future use

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## **Contracts and Specifications**

In order to encourage waste reduction and recycling practices, engineers and architects can develop pertinent language to include in their specifications. Recycling and waste reduction specifications communicate to prospective bidders that the project will not involve the traditional waste management practices. Contract language can address:

1. Waste reduction techniques to use during specific phases of construction
2. Material reuse techniques to employ for specific operations
3. Salvage of specific components
4. Return of unused portions of materials to vendors
5. Recycling programs for specific materials.
6. Bidders may also be asked to develop a waste management plan and cost estimate.

Several advantages are associated with waste reduction and recycling specifications. For bidders, these specifications can eliminate concerns that they may be at a competitive disadvantage if they choose to recycle or practice other waste reduction techniques at the job. The specs can be developed so that the contractor makes a waste management plan and cost estimate for recycling after being selected as the builder on the project. In this manner, it is up to the owner to choose whether to go ahead with the plan if it is more costly, and the cost burden does not fall on the contractor.

Another advantage of waste reduction and recycling specifications is that they clearly identify what types of measures are to be instituted at the job-site. This helps eliminate any confusion about which materials are target recyclables and which waste reduction techniques are to be employed. If pertinent language is tailored to all 16 divisions of the CSI format system for specifications, subcontractors would realize that they are required to be involved in the designated waste reduction and recycling programs along with the general contractor.

When developing language within the specifications that addresses waste reduction and recycling, specifiers should be conscious of the following:

1. Additional reporting requirements usually constitute additional cost
2. Adequate markets must exist for materials targeted for recycling
3. Conditions vary on each project so language must be customized to fit the project
4. Adequate time must be set aside for discussions with bidders if specifications require them to submit recycling alternative.
5. All specifications must be in compliance with local and state waste management regulations

### **CONTRACT SETUP**

It is important to make the specifications as thorough and concise as possible, it is recommended that a general waste provision is included in CSI Division 1 for clarity versus including specific waste recommendations throughout the entire set of specifications.

## **SUBCONTRACTORS**

The general contractor usually provides a dumpster on site for use by all subcontractors; another approach is to require subcontractors to remove their own waste. This approach does not guarantee the recovery of materials, but offers the following benefits. Often when the subcontractor is made responsible for their own waste, materials are used more efficiently. Subcontractors also produce a limited waste stream, by making each sub responsible, their waste is “separated” and therefore easier to recycle.

### **Contract Structure for Subcontractors**

There are several possible approaches to contract structure to ensure compliance.

1. Require participation in the on-site plan. The general contractor may also insert penalties for contamination of on site containers and or offer incentives for meeting goals outlined in the waste management plan.
2. Require subcontractors to dispose of their own waste. This approach takes the burden off of the GC/PM however does not ensure proper disposal of the generated waste.

The best way to ensure compliance is to write a participation clause into your subcontractor contract. Use the power of the contract document to stipulate recycling. In addition, you must orient all site personnel to the day-to-day aspects of your waste management plan. Some additional areas in which stipulations could be made in the subcontract are as follows.

#### **Purchasing**

Subcontractors need to estimate and order accurately, making sure the correct amounts of materials are brought to the site. Work with suppliers to reduce packaging waste and overruns that come on-site. Require suppliers to take back substandard material and packaging.

#### **Pre-construction**

Include waste disposal costs in bids. Require subcontractors to be responsible for their own waste removal. This gives them incentive to produce less waste.

During buyout or while assembling bid packages, ask vendors and suppliers how they will be packaging their items for shipment to the jobsite. It may be possible to use alternatives such as reusable containers for shipping. It is necessary to know what your subcontractors are shipping to the jobsite, and how much of it. Contracts may be written with specific trash removal responsibilities such as removal of cardboard, pallets and crates. Incorporate mandatory participation in a jobsite “reduce, reuse, and recycle” program into your contract language.

## SAMPLE SPECIFICATION AND CONTRACT LANGUAGE RESOURCES

### WasteSpec

Offers comprehensive model specifications for construction waste reduction, reuse, and recycling. The WasteSpec provides the specifier with model language tailored to all 16 divisions of the CSI format system to insert into specifications, information for bidders on estimating recyclable waste, worksheets, and forms. It includes a diskette with the specifications formatted for easy cutting and pasting into standard specifications. Background information and a listing of resources also accompany the model language for the spec writer wanting to do further research or wanting to include specifications to achieve other environmental goals. WasteSpec provides model language requiring the submission of bid alternates for undertaking specific recycling measures as an alternative to landfilling waste. WasteSpec offers the option of requiring the successful bidder to submit a draft waste management plan for approval. The specifier can choose which items must be included in the draft, or the parties can negotiate prior to arriving at a final plan.

The model language also addresses the following areas:

- The use of waste reduction techniques during construction
- Reuse of construction waste materials on the site
- Salvage of C&D waste material from the construction site for resale or reuse by others
- Return of unused construction material to vendors for credit
- Recycling of C&D waste by delivering it to other sites for remanufacture into new products

A sample division of this model specification that is in CSI format is included in appendix F. The complete WasteSpec is available through Triangle J Council of Governments, P.O. Box 1276, Research Triangle Park NC 27709, (919) 558-9343. <http://www.tjcog.dst.nc.us/cdwaste.htm>

#### **CASE STUDY: HOW SPECIFICATIONS WERE USED TO REDUCE WASTE**

**Project Description:** New Construction of corporate headquarters; private sector, 70,000 square feet

**Waste Impact:** Recycled 75% of the project's waste without an increase in project costs

The specifications required the successful bidder to submit draft and final waste management plans. The contractor hired an independent waste manager to work with the subcontractors and contractor to set a realistic waste reduction goal and see that it was met. A 75% waste reduction goal was set, and it was achieved primarily through weekly site meetings, written updates to all site employees, and free lunches. The contractor reported that the waste manager improved his company's ability to recycle waste on all its projects. Another benefit reported by the contractor was increased quality, safety and productivity. For example, to reduce waste, the contractor ordered many items on pallets instead of in boxes. This saved labor time unboxing and also made parts more visible and therefore easier to locate. This building incorporated other aspects of sustainable design such as energy efficiency, indoor air quality, and use of recycled materials and native landscaping.

**CASE STUDY: HOW SPECIFICATIONS WERE USED TO REDUCE WASTE**

**Project Description:** High rise building demolition and new construction in New York City, 1.6 million square feet

**Waste Impact:** Significantly reduced landfill of demolition waste, reducing project costs

Contractors were required to efficiently use resources and energy "to the fullest extent possible," which included recycling waste generated during the demolition and construction process. The contractors and subcontractors were also required to track what was recycled and where it went.

The tracking report for demolition reported recycling of 1,800 tons of steel; 95 tons of scrap metal; 8,000 cubic yards of brick, concrete, and dirt; and 1,000 doors, beams, and copper and stone architectural elements. This building also incorporates state-of-the-art energy saving and environmentally sensitive building design elements.

**GreenSpec**

GreenSpec: The Environmental Building News Product Directory and Guideline Specifications is organized according to the 16-division CSI MasterFormat™ system and features information on more than 1,200 green building products carefully screened by the editors of The Environmental Building News. GreenSpec also includes guideline specification language for a number of CSI subdivisions.

Choosing materials and products that are renewable, biodegradable, low in toxic emissions, and resource-efficient is an important step in reducing the negative impact – and enhancing the positive impact -- of any building. But it can often be a challenge to find materials that are appropriate for the application that also offer environmental benefits. Locating the right products can be a chore, and even when they can be found, it's often difficult to tell which green products really make a difference and which just make claims.

The listings cover more than 200 categories from access flooring to zero-VOC paints and include product descriptions, environmental characteristics and considerations, and contact information with Internet addresses. The guideline specifications provide additional information on selecting and using environmentally preferable products in CSI divisions 1-10. The guideline language was written and designed to be edited and adapted by the user to fit the needs of a particular project. For more information visit: [www.GreenSpec.com](http://www.GreenSpec.com)

**Resourceful Specifications**

Resourceful Specifications is a set of guideline specifications to assist design professionals in choosing environmentally sound, or "green" building materials and techniques. Resourceful Specifications will help reduce the amount of construction debris that ends up in landfills and promote more efficient use of building materials.

Resourceful Specifications covers standard building materials such as wood and concrete. It also includes less common materials such as recycled content products, straw bale construction, and

new composite materials that offer environmentally responsible alternatives to standard building materials and construction practices. *Resourceful Specifications* is available from Siegel & Strain Architects. For additional information contact: [www.stopwaste.org/g-spec.html](http://www.stopwaste.org/g-spec.html)

**CASE STUDY: HOW SPECIFICATIONS WERE USED TO REDUCE WASTE**

**Project Description:** Demolition of police station and adjoining post office, followed by construction of new police station; public sector. 22,000 square feet

**Waste Impact:** 83% of demolition waste was recycled without increasing project costs

The specifications merely "encouraged" disposal alternatives to landfilling, with reuse and recycling to the extent practical. However, this language was followed up by verbal encouragement at the pre-demolition meeting and thereafter. The contractor was also told to document recycling and reuse measures. The contractor was creative and therefore very successful in achieving salvage on the project. For example, bulletproof glass from the old police station was reused in fish tank construction.

**Washington State Department of General Administration's Construction Waste Management Specifications**

To ensure that state projects generate the least amount of waste as possible and that waste that is generated is either reused, salvaged, or recycled the Washington State Department of General Administration's (GA) Division of Engineering and Architectural Services have drafted these Construction Waste Management Specifications. A copy has been provided in the appendices section of this manual.

**King County Environmental Purchasing Program - Contract Language**

King County, Washington has developed general contract language for use in contracts for the procurement of recycled materials, along with new language for sustainability. They have also drafted sample language that can be adapted to your own company. For additional information contact: <http://www.metrokc.gov/procure/green/standpar.htm>

### **LEED STANDARDS (The Green Building Rating System)**

The U.S. Green Building Council (USGBC) has recognized the importance of reducing C&D waste by including it in its criteria for the Leadership in Environmental Energy and Environmental Design (LEED) rating, which buildings will be able to use for advertising, promotion, and educational purposes. The USGBC is a national coalition representing all segments of the building industry. Its members include architects, engineers, product manufacturers, building owners, environmental groups, utilities, universities and federal, state and local governments.

The USGBC began developing LEED over six years ago, when it recognized the need not only for a common definition of a green building, but also for a mechanism to provide market recognition for building owners and design and construction teams that achieved a high level of environmental performance for a building. As a mechanism, the LEED system uses performance-driven measures rather than prescriptive measures. These measures have been proven by pilot projects not to cost more, take longer, result in less attractive buildings, or call for advanced technologies and strategies.

According to the established criteria in Version 2.0 of the LEED Green Building Rating System, all commercial and institutional buildings are eligible for the ratings. They must however, satisfy some basic prerequisites. These include complying with guidelines on erosion and sedimentation control, energy efficiency, ozone depletion, material recycling, indoor air quality, and prohibiting smoking in all building areas. Buildings satisfying all of the prerequisites can then earn points for addressing a wide range of environmental impacts, some of which relate directly to waste prevention.

Four categories, or levels, of certification have been established (certified = 26-32 points; silver level = 33-38 points; gold level = 39-51; platinum level = 52+ points), and buildings achieving certification will be authorized to display a plaque indicating their rating. They will also be able to use the rating in advertising and promotional materials. The USBGC will present a “Green Building of the Year” award for the LEED building with the highest rating. For additional information visit [www.LEEDbuilding.org](http://www.LEEDbuilding.org), or phone at: (415) 445-9500.

### **ISO 14000**

Everyone recognizes the need for environmental protection. Industrialization has contributed to the demise of our air, water, and soil quality. As a result, environmental regulations have been developed for emissions to the air, water, and lands - however, these are external laws that change, making it difficult for a company to remain current. A complimentary method for achieving environmental protection is to use internal standards. This enables a company to integrate quality management systems within their business operations without relying solely on external laws. This is the basis for the ISO 14000 environmental management standards. ISO 14000 is a set of international standards for improving the environmental performance of organizations. It includes the new standard for environmental management systems (EMS) called ISO 14001. Five areas are addressed as a part of this standard:

*Environmental Management Systems* - There are three components to an EMS: a written program; education and training; and knowledge of relevant local and federal environmental regulations. The written program requires the company to be committed to producing the

highest quality product with the lowest possible environmental impact. It sets forth the procedures to be followed to achieve this goal. The EMS must also incorporate the relevant local and federal environmental regulations that apply to their specific facility.

*Environmental Performance Evaluations* - measured by quantifying the impact a business is having on the environment. This is determined initially by an inventory of those impacts such as air emissions, and wastewater discharges. Establishing a baseline from the inventory, a company can then identify indicators of improvement.

*Environmental Auditing* - a routine evaluation of a company's environmental controls. Conducted by an independent third party, it defines the inputs (raw materials, energy) and outputs (waste streams, emissions) for the system. This mass balance approach allows inefficiencies within the system that have an environmental impact to be identified.

*Life Cycle Assessment* - All products have a life cycle; they are born (manufactured), they live (operated) and die (disposed). Life-cycle efforts are geared towards substituting less harmful products and minimization of the waste stream. While the life cycle idea is readily understood, the specifics are often hard to quantify. Life cycle assessment is still a concept for many products versus an exact science. However, the underlying message is very clear, what we make today will be inherited by our children tomorrow.

*Environmental Labeling* - Environmentally friendly products, if they meet consumer needs, have an advantage over their "non-friendly" competitors. Under ISO 14000, the goal is to define standards for environmental labeling, encouraging manufacturers to reduce the environmental impact of their products, while informing consumers about the environmental performance of their products.

There are several good reasons for a company to seek ISO 14000 certification. It will result in a reduction in operational costs as greater efficiencies are achieved, reduce environmental impacts, result in more favorable insurance rates and enable a company to gain competitive advantage. In addition the company will develop a positive image with its shareholders and customers.

## **BEES**

### Building for Environmental and Economic Sustainability Software

Developed by the NIST (National Institute of Standards and Technology) Building and Fire Research Laboratory with support from the U.S. EPA Environmentally Preferable Purchasing Program and the White House-sponsored Partnership for Advancing Technology in Housing (PATH), The BEES software is a powerful technique for balancing the environmental and economic performance of building products based on consensus standards and designed to be practical, flexible, and transparent. The Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 65 building products.

BEES measures the environmental performance of building products by using the environmental life-cycle assessment approach specified in ISO 14000 standards. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and

recycling and waste management. Economic performance is measured using the ASTM standard lifecycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental and economic performance are combined into an overall performance measure using the ASTM standard for Multi-Attribute Decision Analysis. For the entire BEES analysis, building products are defined and classified according to the ASTM standard classification for building elements known as UNIFORMAT II. For more information visit: [www.bfrl.nist.gov/oae/software/bees.html](http://www.bfrl.nist.gov/oae/software/bees.html)

### **CMRA**

The Construction Materials Recycling Association (CMRA) is the first association devoted exclusively to the needs of the rapidly expanding North American construction waste & demolition debris processing and recycling industry. Those needs include:

- Information exchange on issues and technology facing the industry including a listing of available literature on relevant topics;
- Campaign to promote the acceptance and use of recycled construction materials including concrete, asphalt, wood, and gypsum, among others;
- Provide information and support to the C&D recycling industry's side of important issues that affect recyclers.
- Represent the industry at trade shows and other industry functions related to C&D recycling in order to raise the visibility of C&D recycling.
- Financing program allowing members to purchase capital recycling equipment and receive more than competitive rates on the loan.

The recycling of C&D debris is a rapidly growing industry in North America. For some time there has been a distinct need for the C&D debris recyclers, equipment manufacturers, and relevant government officials to have a non-profit association in order to increase use of recycled materials. Many construction material processors, recyclers, end users, solid waste and recycling officials consultants, and equipment manufacturers have expressed a desire for a forum to discuss industry issues. That is what the Construction Materials Recycling Association is providing for the industry. Additional information is available at: [www.cdrecycling.org](http://www.cdrecycling.org).

### **CRBT**

The Center for Resourceful Building Technology is dedicated to promoting environmentally responsible practices in construction. It works to serve as both catalyst and facilitator in encouraging building technologies, which realize a sustainable and efficient use of resources.

CRBT was founded in 1990 by a builder concerned about the rate of natural resource consumption in construction, and the declining quality of dimensional lumber supplied to job sites. CRBT actively promotes resource efficiency in building design, materials selection and construction practices through research, education and demonstration. These activities support CRBT's mission to champion sustainable technologies and community-based approaches that protect natural resources and assist people, especially the economically disadvantaged, in becoming self-reliant.

CRBT seeks to demonstrate to the public that efficient building methods provide a better quality of life and protect the environment. CRBT identifies and promotes building products and methods that do more with less: that provide building materials from reused salvaged, currently

underutilized, or waste materials; that provide sufficient housing with reduced resource use; and that produce less pollution and waste than conventional building materials and technologies. For additional information e-mail [crbt@ncat.org](mailto:crbt@ncat.org), or call (406) 549-4100.

### **EARTH'S 911**

The mission of Earth 911 is to empower the public with community-specific resources for recycling and pollution prevention and allow them to do their part in protecting the environment. While sustainable pollution prevention programs for recycling, water and air pollution are by far the best way to protect the environment, the costs associated with many of them can be astronomical. That is why the use of this Public and Private Sector Partnership for the environment is so important in promoting prevention ideals. Earth's 911 provides a public service for the nation, consolidating environmental resources such as local recycling sites and pollution prevention into one user-friendly network to helping the public to protect the environment. All you need to know to use this service is your postal code. Visit their website at: [www.CLEANUP.org](http://www.CLEANUP.org), or call at 1-800-CLEANUP.

### **UBMA**

The Used Building Material Association is a non-profit, membership based organization that represents companies and organizations involved in the acquisition and/or redistribution of used building materials. They represent for-profit and non-profit companies and organizations in Canada and the United States that acquire and sell used building materials such as windows, doors, and plumbing fixtures. The UBMA also represents companies that reprocess and recycle building materials such as concrete and asphalt.

The mission of UBMA is to help companies gather and redistribute building materials in a financially sustainable way. Their objectives include: increasing availability of used building materials to the building material re-use/recycling industry; helping to develop and promote building material recycling/reprocessing technologies; and developing a materials exchange information medium to assist contractors in redistributing and/or acquiring used building materials. For additional information visit them at [www.ubma.org](http://www.ubma.org), or call 1-877-221-UBMA.

### **NAHB**

The National Association of Home Builders Research Center keeps U.S. homebuilders in tune with new technology and changing needs. Through their programs, including testing and certification of building products, the Research Center helps American homes maintain premier status in a global industry. Research Center studies seek workable answers to real problems of home building and to real ways to improve homes. Future trends and developing technologies are fully analyzed, with an emphasis on the impact that such trends and technologies will have on the way the homes are actually built. The Research Center links the research and product development communities with the practitioners who put methods into practice and products into use. Because the NAHB Research Center was created by the building industry to conduct research and testing, builders place confidence in its findings. Research Center recommendations are publicized and disseminated throughout NAHB's membership, creating a favorable climate for the adoption of desirable change. The NAHB may be contacted at: [www.nahbrc.org](http://www.nahbrc.org)

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## **C & D Waste Management Case Studies**

### **MODEL CONSTRUCTION SITE RECOVERY PROJECT**

Building Use:	Corporate Campus
Buildings:	Three
Size:	Main Buildings (200,000 sq. ft each)
Parking Garages:	70,000 sq. ft (except "test" building, with 145,000 sq. ft.)
Volume:	\$30 million each (approx.)
Location:	City of Redmond, Washington
Building Type:	Steel and Concrete
General Contractor:	Fletcher Wright Construction, Inc. Seattle, WA
Recycling Contractor:	Construction Waste Management Bellevue, WA
Consultants:	O'Brien & Company, Bainbridge Island, WA Sound Resource Management Group, Seattle, WA
Recycling Facts:	Recycling on the "pilot" and "test" buildings saved over \$50,000.

#### **The Project**

Fletcher Wright Construction had been contracted to build three similar office buildings (approximately \$30 million each) for a single client. At the same time, the company began developing a waste reduction program. The primary goals of the program were to produce less waste and to recycle as much of the "waste" material generated as possible.

Fletcher Wright Construction saw the new projects as a unique opportunity to quantify and compare results from their recycling efforts. The company had built the first office building using traditional disposal methods. This building was treated as a "control" building for comparison. In the second building, which coincided with the company's decision to begin developing a recycling program, Fletcher Wright hired a full-service recycling contractor and targeted wood, drywall, and cardboard for recycling.

The recycling contractor provided labeled containers, leveled loads, resorted mis-sorted materials, tarped loads, and took materials to recycling facilities, all for a flat fee. The second building was considered a "pilot" building for the project.

#### **The Results**

Monthly disposal and recycling records showed 45% of the materials generated (by weight) on the "pilot" building project were recycled, representing approximately \$17,000 savings in waste management costs. However, interviews and photo documentation of the "pilot" project revealed significant additional potential in terms of recovering targeted materials from the waste stream. The project team worked with Fletcher Wright field personnel to analyze these results and the methods used to achieve them. This information, combined with the results of field research conducted around the country, directed the development of *Recycling Plus Program* materials, which were then tested on the third office building. Again, the "test" building was similar to the previous two building projects compared, except for a significantly larger parking garage. In the "test" building, the same materials were targeted for recovery, with the addition of miscellaneous metals. In addition, the same full-service recycling contractor was used. Monthly

disposal and recycling records showed 54% of materials generated on the site were recycled, representing over \$35,000 in savings.

Based on the team's analysis, at least one-half of the 9% overall increase in recycling (between the "pilot" and "test" building) can be attributed to the use of the *Recycling Plus Program*. The rest of the increase is due primarily to the fact that more recyclable wood waste was generated on the project overall, both because of the larger garage, and because all of the wood reused from the first two buildings was recycled as part of cleanup for the third and final building. It was also due to the fact that some learning had occurred on the previous project.

### **The Recycling Plus Program**

The *Recycling Plus Program* developed as part of the Fletcher Wright demonstration project can help contractors set up or improve existing recycling programs. The result will be increased job-site recovery and lower waste disposal bills.

The Recycling Plus Program is modeled after successful safety programs, using training meetings, visual aids, and program incentives. Recycling Plus materials include a user-friendly manual composed of three sections: a Management guide summarizing the Program and outlining management's role in operating a successful company program; a pull-out Field Guide providing project managers and superintendents with practical planning, training, and evaluating tools; and a pull-out Subcontractor Kit informing subs how they can participate.

The *Recycling Plus Program Manual* (including all *Recycling Plus Program* materials) is available from the Clean Washington Center. Supplied with the *Manual* is a blank case study form to be completed by contractors who participate in the program and are willing to provide information about particular projects.

### **CITATION HOMES**

Building Use: Residential  
Buildings: 95  
Home Size: 1,875 – 2,300 sq. ft. each  
Volume: \$13 million each (approx.)  
Location: Union City, California  
Building Type: Wood Frame  
General Contractor: Citation Homes, Santa Clara, CA  
Recycling Contractor: Green Waste Recovery, Inc., San Jose, CA  
Recycling Facts: 86% of project waste was recycled, 1044 tons of construction waste was diverted from the landfill

### **The Project**

A new Union City housing development stands as a model of how to keep debris out of our landfills. Recently, Citation Homes completed the first phase of the Inspirations at Foothill Glen project, a development of 95 large, single-family homes ranging in size from 1875 to 2300 square feet. Rather than paying to haul construction “waste” materials, and then paying to dispose them at the landfill, Citation Homes contracted with Green Waste Recovery to collect

and transport the excess wood, asphalt, concrete, gypsum and metals from the jobsite for recycling. The recycling subcontractor brought in six-cubic-yard stackable containers. The small containers could be moved with a forklift as needed. Green Waste Recovery provided an on-site laborer who placed all recyclable materials in the containers. Leftover wood became mulch or fuel for co-generated power. Sheetrock scraps were turned into a gypsum soil amendment. Concrete and asphalt were ground to be used as road base.

Citation Homes Construction Manager Cy Hotovec sees economic, as well as environmental, benefits in recycling. “We have had good success with recycling over the past five years,” he said. “Since materials can often be recycled at less cost than we would pay to transport and dump them, it makes good sense for the bottom line.”

The Waste Management Authority is working with its local jurisdictions to develop a model recycling ordinance for all construction projects. Such an ordinance would help jurisdictions like Union City -- whose 4.7% growth rate makes it the fastest growing city in Alameda County.

### **The Results**

In partnership with its recycling sub-contractor, Green Waste Recovery Inc., Citation was able to recover and recycle over 1,000 tons of materials during the construction phase -- 86% of all waste generated on the project. Green Waste Recovery’s recycling efforts provided added value to the project by keeping the construction site picked up on a daily basis, which made work more efficient and safer.

“This project clearly demonstrates what can be accomplished through careful business planning,” said Wendy Sommer, Program Manager for the Alameda County Waste Management Authority, a regional agency whose mission is to help cities and counties achieve state and local recycling mandates. “The 86% recycling rate is very impressive,” she said, “Citation has done an outstanding job.”

### **Recycling Benefits**

86% of project waste recycled, 1044 tons overall (an average of 11 tons per house), including the following materials:

- 631 tons of wood
- 74 tons of cardboard and paper
- 116 tons of concrete, dirt and asphalt
- 62 tons of copper, aluminum, and other metals
- 161 tons of gypsum board

For more information, The Alameda County Waste Management Authority offers free technical assistance to C&D contractors. They may be contacted toll free at 1-877-STOPWASTE or visit [www.stopwaste.org](http://www.stopwaste.org)

## **BOEING COMMERCIAL AIRPLANE GROUP HEADQUARTERS**

Building Use: Commercial Office Building  
Buildings: One  
Size:  
Volume:  
Location: Renton, WA  
Building Type: Steel and Concrete  
General Contractor: Baugh Construction  
Recycling Contractor:  
Recycling Facts: 97% job recycling rate, saving over \$90,000.

### **The Project**

The contractor for the Boeing Commercial Airplane Group Headquarters project, Baugh Construction, has made a commitment to waste prevention and recycling – building it into its business. Each project has a recycling plan that defines goals and objectives; frequent meeting keep all the on-site personnel current with the plan and its practices; and subcontractors stay in the loop through meetings and the establishment of on-site standards.

Baugh's recycling carried this commitment into the Boeing Headquarters project. Baugh construction recycled wood, drywall, concrete, asphalt, metals, cardboard, and land clearing debris. They recycled on-site concrete and asphalt, breaking it down for roadbeds and building pads. The 1-1/8" form plywood from a previous project got new life at Boeing, and all wood from the site-clearing operation was chipped and used in non-structural applications.

Baugh used many innovative recycled-content materials at the Boeing site: the receptionist's counter-top is recycled newsprint; the carpet is manufactured from 100% recycled denim; remanufactured scrap steel supports the structure; wood paneling was harvested from sustainable forests; and the parking lot curbs and landscaping headers are recycled plastic.

### **The Results**

Following this its plan, the builder achieved an amazing 97% recycling rate. Baugh Construction also improved their bottom line by saving \$90,000. The materials and the amount of each that was recycled was:

- 64 tons of wood
- 33.67 tons of drywall
- 6,401 tons of concrete
- 39 tons of metals
- 1.5 tons of cardboard
- 8.3 tons of land clearing debris

## **MICROSOFT DATA CENTER**

Building Use:	Commercial, Office
Buildings:	Remodel and Addition
Size:	31,000 sq. ft. remodel and 19,000 sq. ft. addition
Volume:	
Location:	Bothell, WA
Building Type:	Steel and Concrete
General Contractor:	H.S. Wright Construction, Seattle, WA
Recycling Service:	Doherty's Construction Waste Management
Recycling Facts:	1,260 total tons recycled and \$201,300 total cost savings during demolition and construction phases.

### **The Project**

Scheduling is crucial for fast-track commercial projects. The Microsoft Data Center was no exception. H.S. Wright worked around the clock to remodel an existing 31,000 sq. ft. building, add a 19,000 sq. ft. mezzanine, build-out 6,000 sq. ft. of offices, restructure 10,000 sq. ft. of roof area, and install several tons of complex mechanical and electrical systems; all within six months. During that time, they recycled over half of their construction waste, nine tons out of ten if you include demolition waste. Like many projects, there were distinct phases that generated only one kind of material. It could all be collected into the same recycling dumpsters, without spending time to separate it.

During the construction phase, crews collected wood waste in a designated area. According to the project superintendent, throwing materials in piles instead of dumpsters shaved off a little time from the clean-up process. H.S. Wright then used a recycling service to sort through the pile and haul the wood away.

The electrical subcontractor requested their suppliers not wrap things individually in cardboard. Instead, items like lighting units were simply shipped to the site on a pallet. When asked about breakage, the electrical foreman replied that it was no worse than usual, because when things are not wrapped up in cardboard, the workers are actually more careful handling them.

### **The Results**

The results were impressive. Without slowing down their schedule, H.S. Wright managed to recycle 1,260 tons of C&D waste. Though they went about the job thoughtfully, they didn't take extraordinary measures. Recycling and reducing waste does not have to slow down a fast track job. The breakdown of cost savings and materials recycled were as follows:

- 54% recycling rate in the construction phase, saving \$6,200
- 93% recycling rate for combined C&D phases, with total cost saving of \$195,100
- 55 tons of wood recycled
- 1,205 tons of concrete recycled



## APPENDIX A – JOBSITE WASTE MANAGEMENT ACTION WORKSHEET

**Project Name:** \_\_\_\_\_

**City and County:** \_\_\_\_\_

**Recycling Site Coordinator:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**REDUCE, REUSE AND BUY RECYCLED ACTION ITEMS**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

**RECYCLING GOAL - To recycle \_\_\_\_ % of waste generated on the site.**

**RECYCLING SERVICE PROVIDERS AND TARGETED MATERIALS.**

**Action Items**    Evaluate Cost and Services Offered    Service Provider Agreements in Place

**Company #1**  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Company #2**  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

<b>Materials</b>	<b>Peak Generation *</b>	<b>Mtls. Recipient **</b>
<input type="checkbox"/> Wood	_____	_____
<input type="checkbox"/> Metal	_____	_____
<input type="checkbox"/> Cardboard	_____	_____
<input type="checkbox"/> Drywall	_____	_____
<input type="checkbox"/> _____	_____	_____
<input type="checkbox"/> _____	_____	_____

<b>Materials</b>	<b>Peak Generation *</b>	<b>Mtls. Recipient **</b>
<input type="checkbox"/> Wood	_____	_____
<input type="checkbox"/> Metal	_____	_____
<input type="checkbox"/> Cardboard	_____	_____
<input type="checkbox"/> Drywall	_____	_____
<input type="checkbox"/> _____	_____	_____
<input type="checkbox"/> _____	_____	_____

\* Point in project (week, phase, dates) when most volume will be generated in material category.  
 \*\* Only applicable if you are handling all recycling activities with in-house staff.

**RECYCLING OPERATIONS - Consult Planning Sections for more information.**

<b>Action ***</b>	<b>Who/What/When</b>
<input type="checkbox"/> Choose bins/collection methods	_____
<input type="checkbox"/> Order bins - oversee delivery	_____
<input type="checkbox"/> Site bins/collection sites for optimum convenience	_____
<input type="checkbox"/> Label/sign bins/collection sites	_____
<input type="checkbox"/> Sort or process wood	_____
<input type="checkbox"/> Sort or process metal	_____
<input type="checkbox"/> Sort or process drywall	_____
<input type="checkbox"/> Sort or process cardboard	_____
<input type="checkbox"/> Sort or process _____ (material)	_____
<input type="checkbox"/> Schedule material pickups/dropoffs	_____
<input type="checkbox"/> Document material pickups/dropoffs	_____

\*\*\*Depending on the service option you choose, action items may be the responsibility of your field personnel, your hauler, a full-service recycling contractor, or your subcontractors.

**COMMUNICATION ACTION ITEMS - Check only items you plan to use.**

Action	Who/What/When	Completed
<input type="checkbox"/> Complete Job Site Action Plan	_____	<input type="checkbox"/>
<input type="checkbox"/> Hold Orientation/Kick-off Meeting	_____	<input type="checkbox"/>
<input type="checkbox"/> Mention Program & Progress in Weekly Job Site Meetings	_____	<input type="checkbox"/>
<input type="checkbox"/> Use Implementation Checklist	_____	<input type="checkbox"/>
<input type="checkbox"/> Post Goals/Progress (Signage)	_____	<input type="checkbox"/>
<input type="checkbox"/> Post Targeted Materials (Signage)	_____	<input type="checkbox"/>
<input type="checkbox"/> Distribute Tip Sheets for Job Site Personnel	_____	<input type="checkbox"/>
<input type="checkbox"/> Distribute Subcontractor Kit with Tip Sheets	_____	<input type="checkbox"/>
<input type="checkbox"/> _____	_____	<input type="checkbox"/>

**MOTIVATION ACTION ITEMS - Check only items you plan to use.**

Action	Who/What/When	Completed
<input type="checkbox"/> Use Formal Agreements Committing Subs to Program	_____	<input type="checkbox"/>
<input type="checkbox"/> Fork-Lift Operations Police Site	_____	<input type="checkbox"/>
<input type="checkbox"/> Require Mis-Sorters to Re-Sort Bin	_____	<input type="checkbox"/>
<input type="checkbox"/> Provide Stickers, T-shirts, or Hats	_____	<input type="checkbox"/>
<input type="checkbox"/> Public Recognition of Participating Subs	_____	<input type="checkbox"/>
<input type="checkbox"/> Serve Refreshments at Meetings	_____	<input type="checkbox"/>
<input type="checkbox"/> Award T-shirts (if not used as incentives)	_____	<input type="checkbox"/>
<input type="checkbox"/> Letters of Recognition	_____	<input type="checkbox"/>
<input type="checkbox"/> Awards Luncheon	_____	<input type="checkbox"/>
<input type="checkbox"/> _____	_____	<input type="checkbox"/>

**EVALUATION ACTION ITEMS - Check only items you plan to use.**

Action	Who/What/When	Completed
<input type="checkbox"/> Perform Short Form Waste Audit	_____	<input type="checkbox"/>
<input type="checkbox"/> Perform Mid-Course Assessment	_____	<input type="checkbox"/>
<input type="checkbox"/> Perform Monthly Cost and Materials Tracking	_____	<input type="checkbox"/>
<input type="checkbox"/> Perform Final Evaluation	_____	<input type="checkbox"/>
<input type="checkbox"/> _____	_____	<input type="checkbox"/>

**PROGRAM BENCHMARKS - 10 STEPS**

Action	Who/What/When	Completed
<input type="checkbox"/> Develop Job Site Action Plan	_____	<input type="checkbox"/>
<input type="checkbox"/> Ensure Buy-In of Field Personnel and Subs	_____	<input type="checkbox"/>
<input type="checkbox"/> Implement Your Plan On-Site	_____	<input type="checkbox"/>
<input type="checkbox"/> Implement Communication Action Items	_____	<input type="checkbox"/>
<input type="checkbox"/> Implement Motivational Action Items	_____	<input type="checkbox"/>
<input type="checkbox"/> Evaluate/Track Progress	_____	<input type="checkbox"/>
<input type="checkbox"/> Reward Successes	_____	<input type="checkbox"/>
<input type="checkbox"/> Incorporate Improvements in Company Program	_____	<input type="checkbox"/>
<input type="checkbox"/> Develop a Plan for Your Next Project	_____	<input type="checkbox"/>

**APPENDIX B – JOB-SITE RECYCLING WORKSHEET FOR SMALLER JOBS**

<b>What material will you target?</b>	<b>Condition of material*</b>	<b>How will it be handled on site?</b>	<b>Who will haul it?</b>	<b>Where will it be taken?</b>
<input type="checkbox"/> Wood				
<input type="checkbox"/> Cardboard				
<input type="checkbox"/> Ferrous metal				
<input type="checkbox"/> Non-ferrous metal				
<input type="checkbox"/> Drywall				
<input type="checkbox"/> Concrete/ Asphalt				
<input type="checkbox"/> Other				

**Action Items**

- Complete this Job Site Recycling Plan and post on site.
- Commit subcontractors to recycle in Subcontractor Agreement.
- Keep subcontractors and workers aware and informed of Recycling Program.
- Require individuals to properly sort recyclables and hold them responsible for mis-sorted loads.
- Track and promote recycling results.

**Follow these procedures to maximize recycling at your jobsite:**

- Separate and recycle wood, cardboard, metal, drywall and other recyclable materials.
- Make sure both interior containers and exterior recycling dumpsters are convenient and clearly labeled.
- Train new personnel where the recycling containers are located and which materials are recyclable.
- Move trash and recycling containers close to each other, making it convenient to recycle.
- Store materials to prevent loss from damage.
- Check recycling and garbage bins daily for mis-sorted materials.
- Provide training to people who are mis-sorting recyclable materials or ask your superintendent or safety manager to inform them.
- Identify large quantities of waste that are not being recycled, and ask your superintendent if they can be recycled.

## APPENDIX C – WASTE STREAM AUDIT: ANALYSIS AND ASSESSMENT

Project Name \_\_\_\_\_ Date \_\_\_\_\_

On-Site Recycling Coordinator: \_\_\_\_\_

Major Subcontractors On site: \_\_\_\_\_

\_\_\_\_\_

1. Indicate the volume of each garbage and recycling container on site and indicate the percent full in the following chart. Then indicate the three bins to be used for the audit.

Container	Cubic Yds	Percent Full	Audit
Garbage Receptable # 1			
Garbage Receptable # 2			
Garbage Receptable # 3			
Garbage Receptable # 4			
Wood Recycling Container			
Metal Recycling Container			
Cardboard Recycling Container			
Other Recycling Container ( )			
Other Recycling Container ( )			
TOTAL WASTE (CY)			

2. Estimate the percentage and amount of recyclables ending up in one garbage receptacle and the percentage and amount of mis-sorted materials in two recycling bins.

Material Types	Garbage Receptacle		Recycling Container		Recycling Container	
	Show % &CY of recyclable materials		Show % &CY of mis-sorted materials		Show % &CY of mis-sorted materials	
	% of total	CY (approx)	% of total	CY (approx)	% of total	CY (approx)
Wood						
OCC cardboard						
Gypsum						
Metal						
Asphalt paving						
Concrete (includes block)						
Bricks						
Composition shingles						
Plastic (#1 and #2)						
Other recyclable						
Other recyclable						
Garbage (waste not targeted)						
Total	100%	CY	100%	CY	100%	CY

3. Mark the areas you feel need attention to help you meet the project's recycling goals.

- |  |   |  |
|--|---|--|
| <input type="checkbox"/> Lack of space to place containers                       | <input type="checkbox"/> Pick-ups not frequent enough | <input type="checkbox"/> Job schedule is prohibitive     |
| <input type="checkbox"/> Lack of close-by work containers                        | <input type="checkbox"/> Pick-ups too frequent        | <input type="checkbox"/> In-house crew not knowledgeable |
| <input type="checkbox"/> Lack of totes to carry materials to bins                | <input type="checkbox"/> Recycler not responsive      | <input type="checkbox"/> In-house crew not responsive    |
| <input type="checkbox"/> Materials not recyclable                                | <input type="checkbox"/> Costs prohibitive:           | <input type="checkbox"/> Subs not knowledgeable          |
| <input type="checkbox"/> Recycling bins are not available (list material types): | _____ Hauler  | <input type="checkbox"/> Subs not cooperative            |
| _____  | _____ Labor   | <input type="checkbox"/> Other _____                     |
| _____  | _____ Space   |  |
| _____  | _____ Bin   |  |

4. Waste Reduction—Below is a list of actions you can take to prevent waste generation on site. Mark the practices currently being used with a (C) and those you plan to implement on this project with a (P).

- |  |   |
|--|---|
| _____ Use less material                              | _____ Order in bulk                                     |
| _____ Prevent materials damage during handling       | _____ Coordinate just-in-time deliveries                |
| _____ Store materials properly                       | _____ Use products with recycled-content                |
| _____ Make use of scraps                             | _____ Use accurate materials estimating procedures      |
| _____ Avoid contaminating waste with toxic materials | _____ Use precut and prefab components                  |
| _____ Plan to salvage                                | _____ Reduce toxic materials use                        |
| _____ Reuse salvaged materials                       | _____ Choose strong mat. & exploit structural advantage |
| _____ Sell or donate salvaged materials              | _____ Use high grade materials                          |
| _____ Reduce packaging waste                         | _____ Other: _____                                      |

Other Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## APPENDIX D – MODEL WASTE MANAGEMENT CONTRACT LANGUAGE

### *General Administration Division of Capitol Facilities, Washington State* **CONSTRUCTION WASTE MANAGEMENT**

#### I. Description

A. The owner desires that this project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors shall be employed.

B. Of the inevitable waste that is generated, as many of the waste materials as economically feasible shall be reused, salvaged, or recycled. This is consistent with the intent of RCW 39.04.135 and is mandated whenever practicable.

C. With these goals the contractor shall develop a Waste Management Plan for this project. Attachments are included which may be used in the development of this plan.

#### II. Waste Management

##### A. Plan

##### 1. Required Sections

Within fourteen working days after receipt of the Notice to Proceed, or prior to any waste removal, whichever occurs first, the contractor shall submit three copies of the Draft Waste Management Plan to the Architect and owner. The plan should contain the following:

- a. list of each material proposed to be salvaged, reused or recycled during the course of the project
- b. Estimated quantities for each waste stream
- c. Separation requirements
- d. On-site storage method for each waste stream
- e. Transportation method for each waste stream
- f. Destination of each waste stream
- g. Estimated tip fee or rebate for each material

##### 2. Materials

The list of these materials is to include, at a minimum:

- a. Cardboard
- b. Carpet
- c. Clean dimensional wood
- d. Land clearing debris
- e. Concrete
- f. Bricks and Concrete Masonry Units (CMU's)
- g. Asphalt paving
- h. Metals from banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze
- i. Gypsum

- j. Excavated soils
- k. Glass
- l. Wood

1. Additional Information

Include the names for each subcontractor who will transport solid or hazardous waste from the site and the name of the receiving facility that will accept waste for disposal.

B. Resources

The resources listed below are available from the owner. A sample Waste Management Plan and Waste Management Plan forms are available as an appendix to this section. These materials may be used for development of the Waste Management Plan. In addition, the contractor may request specific technical assistance or referrals from the following resources:

Sustainable Design and Construction  
Program Coordinator  
Facilities Engineering Services Group  
Engineering and Architectural Services  
Department of General Administration  
Sustainable Building Specialist  
Solid Waste & Financial Assistance Program  
Department of Ecology

C. Review and Approval

1. The Draft Waste Management Plan will be reviewed by the Architect for comment and approval with a copy going to the owner.

- a. The plan is checked to make sure all materials that may be economically recycled are listed.
- b. The plan is also checked for the haulers, recyclers and disposal facilities, to include recycling, general waste and hazardous waste facilities.
- c. Plan review comments are made by the Architect. Once an acceptable response is received the plan is approved.

D. Implementation

1. Submission of Progress Reports: The Contractor shall submit monthly a progress report summary of waste generated at the project. The summary shall be submitted on a form acceptable to the owner and shall contain the following information:

- a. For each material recycled, reused, or salvaged from the project, the amount (in tons or cubic yards), the date removed from the job site, the receiving party, the transportation cost, the amount of any money paid or received for the recycled or salvaged material, the net total cost or savings of salvage or recycling the material. Include manifests, weight ticket receipts or invoices.
- b. The amount (in tons or cubic yards) of material landfilled from the project, the location of the receiving facility, the total amount of tip fees paid at the landfill, and the total disposal cost. Include manifests, weight tickets, receipts and invoices.

## APPENDIX E – SAMPLE WASTE MANAGEMENT SPECIFICATIONS

### *The City of Los Angeles Integrated Solid Waste Management Office* **WASTE MANAGEMENT SPECIFICATIONS -- GENERAL PROVISIONS**

The sample specification that follows is adapted from *Solid Resources Management Specification: Contractor Guidelines and Requirements for Reuse, Salvage, and Recycling of Construction, Demolition and Landclearing Materials*, courtesy of the City of Los Angeles Integrated Solid Waste Management Office (213-847-4321). Additional provisions were adapted from *Waste Reduction and Recycling Demonstration Project Final Report*, submitted to Seattle Solid Waste Utility by O'Brien & Company. To order this specification on disk, call NRDC at 415-777-0220 and ask for the Wood-Use Efficiency Department.

#### **Job-Site Waste Reduction Specification**

##### **1. DESCRIPTION**

1.1 This section includes procedures for ensuring optimal diversion of solid resources generated by the Work within the limits of the Construction Schedule, Contract Sum, and available materials, equipment, and products.

1.1.1 Assembly Bill 939, California Solid Waste Management Act, requires that localities throughout the state develop source reduction, reuse, recycling, and composting programs to reduce the tonnage of solid waste disposed of in landfills by 50 percent by the year 2000. Construction, demolition, and landclearing debris generated by the development are among the materials targeted by [city] to achieve these diversion rates, and the Developer supports these initiatives.

1.1.2 The Contractor shall participate in promoting efforts of the Developer or its representative to create a resource-efficient and environmentally sensitive Project and to effect optimum control of solid waste and recoverable resources generated in the Work.

1.1.3 The Developer has adopted recycled product procurement policies and the Contractor shall use products with post-consumer recycled content to the greatest extent feasible. Refer to the most recent issue at the date of bid of *A Resource Guide to Recycled-Content Construction Products* published by the Los Angeles Integrated Solid Waste Management Office (call 213-847-1444 to obtain a copy).

1.2 Related Sections: Documents affecting work of this Section include, but are not necessarily limited to, the following Contract Specifications:

- Site Clearing, 02230
- Demolition, 02220
- Asbestos Removal, 13280
- Earthwork, 02300

##### **2. SUBSTITUTIONS**

Should the Contractor desire to use procedures, materials, equipment, or products which meet the requirements of these specifications but are more environmentally sensitive, the Contractor shall submit these substitutions in accordance with Substitutions and "Or Equal" Submittal of the General Requirements.

### **3. SOLID RESOURCES MANAGEMENT PLAN**

3.1 Contractor shall conduct a site assessment and estimate the types and quantities of materials under the Work that are anticipated to be feasible for source separation for recycling or reuse, either on-site or off-site, and shall note the procedures intended for a recycling, reuse, and salvage program. Refer to the most recent issue of *Construction and Demolition Waste Recycling Guide*, and *Wood You Recycle?*, published by the Los Angeles Integrated Solid Waste Management Office, for a partial list of facilities that accept these materials for recycling.

3.2 After award of Contract and prior to the commencement of the Work, the Developer or its representative shall schedule and attend a meeting with the Contractor to discuss the Contractor's proposed Solid Resources Management Plan. Not more than 20 working days after the meeting, the Contractor shall draft and submit to the Developer or its representative a written Solid Resources Management Plan, formatted as shown in Attachment A. This Plan shall be submitted to allow the Developer or its representative and the Contractor an opportunity to develop a mutual understanding regarding the recycling, reuse, and recycled-content procurement programs and shall include, but not be limited to, the following:

- Contractor and project identification information
- Types of solid resource materials and wastes that will be produced
- Materials to be salvaged, reused, and recycled, both on-site and off-site
- Procedures to be used
- Estimated quantities of materials
- Names and locations of salvage, reuse, and recycling facilities/sites
- Names and locations of waste disposal facilities/sites

3.3 Incorporating the review and comments of the Developer or its representative, Contractor shall revise and resubmit the Solid Resources Management Plan. The Developer/representative's review and comment on the Solid Resources Management Plan will not otherwise relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures.

### **4. RECYCLING, REUSE, AND SALVAGE PROCEDURES**

#### **4.1 Recycling, Reuse, and Salvage Facilities**

The most recent issues of *Construction and Demolition Waste Recycling Guide* and *Wood You Recycle?*, published by the Los Angeles Integrated Solid Waste Management Office, are incorporated herein by reference. For more information, contact the LA. Integrated Solid Waste Management Office, Room 1450 City Hall East, 200 N. Main St, Los Angeles, CA 90012, 213-847-1444; fax 213-847-3054. These guides are updated regularly.

#### **4.2 Development and Implementation of Procedures**

Based upon the Contract Documents, the Contractor's Solid Resources Management Plan, estimated quantities of materials, and availability of salvage, reuse, and recycling facilities, Contractor shall develop and implement procedures to reuse, salvage, and recycle materials to the greatest extent feasible. Procedures shall include source-separated recycling as well as mixed recycling efforts. On-site recycling shall be considered.

#### **4.3 Salvage and Reuse**

4.3.1 Contractor shall perform a site pre-assessment, identify materials that are feasible for salvage, and determine requirements for site storage and transportation to salvage facilities. A salvage/reuse program shall be implemented to the greatest extent feasible. A partial list of facilities is included in the most recent issue of *Construction and Demolition Waste Recycling Guide*, published by the Los Angeles Integrated Solid Waste Management Office.

4.3.2 Where practicable and cost-effective, wood shall be carefully dismantled and sold to a reuser, salvage dealer, or wood recycler. Fixtures, furnishings, and equipment shall be removed from the facility intact and sold or donated to an appropriate organization. Any additional items (e.g., windows and doors), when feasible, shall be salvaged, source-separated, and taken to a recycling company, materials exchange, or similar facility.

4.3.3 The following salvage options shall be considered at a minimum:

- California Materials Exchange (CALMax) -- a free program sponsored by the CIWMB designed to help businesses find markets for materials that traditionally would be discarded. To obtain a current listing, call 916-255-2369 or 800-553-2962.
- LA Shares -- a non-profit materials exchange that accepts excess reusable materials from private donors and distributes them to various non-profit organizations throughout the City. 213-485-1097.
- Habitat for Humanity Los Angeles (HFH-LA) -- a non-profit housing organization that rehabilitates and builds housing for low income families. 213-975-9757. HFH-LA sites requiring donated materials vary.

#### **4.4 Source-Separated Recycling**

4.4.1 The Contractor shall develop and implement a program to include on-site separation, to the greatest extent feasible, of the following materials:

- Asphalt
- Brick
- Cardboard
- Concrete, concrete block, masonry, rocks, and rubble
- Dirt (clean dirt will be taken to a clean fill site)
- Drywall (source-separated and recycled or ground and used as soil amendment on-site)
- Metal, ferrous and non-ferrous (including HVAC equipment, fasteners, piping, chillers, generators, boilers, doors, aluminum paneling)
- Wood
- Green materials (e.g., tree trimmings)

4.4.2 Recycling plans shall estimate the amount of recyclable materials to be used on-site in the Work and include a program for off-site recycling of any excess material that cannot be used in the Work.

4.4.3 Each recycling facility or waste processor has requirements as to the way materials must be prepared to be accepted and to what degree materials can be contaminated. The Contractor shall provide separate containers or enclosures to facilitate its own recycling efforts and those of Subcontractors in order to meet those requirements and to meet specifications identified in the Contract Documents. A separate container shall be provided for non-recyclable, non-reusable trash.

4.4.4 Subcontractors shall be required to recycle the above materials, follow source separation requirements for each material, and use the appropriate on-site container/enclosure for each material.

4.4.5 Separation arrangements are subject to approval of the Developer or its representative.

#### **4.5 Mixed Debris Recycling**

Contractor shall develop and implement a program for commingled recycling of construction and demolition materials that cannot be feasibly source-separated. Such materials shall be legally transported to a mixed recycling facility. These facilities are listed in the most recent issue of *Construction and Demolition Waste Recycling Guide*, published by the Los Angeles Integrated Solid Waste Management Office.

#### **4.6 Waste Disposal**

4.6.1 Using a permitted waste hauler or its own trucking services, the Contractor shall legally transport non-recyclable, non-reusable materials to a transfer station or disposal facility that can legally accept the materials for the purpose of disposal.

4.6.2 The Contractor shall not burn, bury, or otherwise dispose of solid waste on the project job site.

#### **4.7 Hauling**

4.7.1 Contractor shall arrange for delivery of materials, by a permitted waste hauler or using its own trucks, to facilities that can legally accept construction and demolition materials for purpose of reuse, recycling, or disposal.

4.7.2 Prior to delivering materials, Contractor shall familiarize itself with the specifications for acceptance of construction and demolition materials at recycling facilities. The most recent issue of *Construction and Demolition Waste Recycling Guide*, published by the Los Angeles Integrated Solid Waste Management Office, includes a partial list of these facilities.

### **5. MATERIALS TRACKING FORM**

5.1 To each application for progress payment submitted to the Developer or its representative, the Contractor shall attach a Materials Tracking Form; a sample is shown as Attachment B. The Materials Tracking Form shall quantify all materials generated in the Work and document their disposition (salvage, reuse, recycling, or disposal) as specified herein.

5.2 The Materials Tracking Form shall identify materials sent to:

- . Source-separated recycling facilities
- . Mixed debris recycling facilities
- . Class III landfills (including inert materials accepted as daily cover)
- . Inert fills
- . Inert backfill sites other than inert fills
- . Other diversion sites (specify)

5.3 Contractor shall complete each Materials Tracking Form as described below.

5.3.1 Fill in the project title; project work order number; progress payment number; name of company submitting the Materials Tracking Form; the printed name, signature, and daytime phone number of the person completing the form; the beginning and ending dates of the period covered; and the date that the form is completed.

5.3.2 Report disposal/recycling either in tons or in cubic yards: if scales are available at facility, report in tons; otherwise, report in cubic yards. Indicate zero (0) if there is no quantity to report for a type of material.

5.3.3 Indicate locations to which materials are delivered.

5.3.4 Attach to the form legible copies of weigh tickets, receipts, invoices, or other documents that specifically identify the Project generating the materials. Said documents must be from sites and/or facilities that can legally accept the materials for purposes of reuse, recycling, or disposal.

5.4 Failure to submit the Materials Tracking Form and supporting documentation may render the application for progress payment incomplete and delay progress payments.

## **6. REVENUE**

Revenues or other savings obtained from recycled, reused, or salvaged materials shall accrue to Contractor unless otherwise noted in the Contract Documents.

## APPENDIX F – SAMPLE CSI SYSTEM WASTE SPECIFICATIONS

*Triangle J Council of Governments*

*WASTESPEC – Using Specifications to Reduce Construction Waste*

The sample specification that follows is adapted from the *WasteSpec* notebook, a manual that includes model specifications tailored to all sixteen CSI divisions. Division 6 (Wood and Plastic) provisions are included here, but the complete version of *WasteSpec* is available through Triangle J Council of Governments, P.O. Box 1276, Research Triangle Park NC 27709, (919) 558-9343.

[http://www.tjcog.dst.nc.us/cd\\_waste.htm](http://www.tjcog.dst.nc.us/cd_waste.htm)

### – DIVISION 6 – WOOD AND PLASTICS

REFER TO THE FOLLOWING RELATED SPECIFICATION DOCUMENTS AND SECTIONS FOR TECHNICAL SUPPORT, PROCEDURES, AND COORDINATION WHEN USING THIS WASTESPEC DIVISION:

- 00000 DOCUMENTS
- DIV 1 GENERAL REQUIREMENTS
- 01010 SUMMARY OF THE WORK
- 01094 DEFINITIONS
- 01500 CONSTRUCTION FACILITIES
- 01505 CONSTRUCTION WASTE MANAGEMENT

SIGNIFICANT FACTORS IN THE GENERATION OF WASTE IN THIS DIVISION INCLUDE WOOD REJECTS AND OFFCUTS, CORRUGATED CARDBOARD, PACKING MATERIALS, FIELD CONDITIONS, TEMPORARY BRACING, PROTECTION, PLASTICS, METALS, AND ESTIMATING ERRORS.

THIS DIVISION HAS VERY GOOD POTENTIAL FOR THE INCORPORATION OF PRODUCTS AND MATERIALS WITH RECYCLED CONTENT. OVER ONE HUNDRED PRODUCTS ARE AVAILABLE. SEE APPENDIX E FOR RESOURCES.

UNDER THE FOLLOWING OR SIMILAR HEADINGS, INSERT APPLICABLE STATEMENTS.

#### PART 1 GENERAL RELATED SECTIONS

- A. Section 01500 Construction Facilities.
- B. Section 01505 Construction Waste Management.

#### PART 2 PRODUCTS ENVIRONMENTAL CONSIDERATIONS

[THIS IS AN APPROPRIATE LOCATION FOR ADDITIONAL LANGUAGE PERTAINING TO ENVIRONMENTAL ISSUES BEYOND THE SCOPE OF THIS WASTESPEC, SUCH AS THE FOLLOWING PROVISIONS.]

A. Where hardwoods or tropical or endangered woods are specified, only those with written certification of sourcing from sustainably managed forests will be accepted. Acceptable certifiers are: [EDIT TO SUIT PROJECT.]

[LESSER KNOWN AND SUSTAINABLY HARVESTED ALTERNATIVES TO ENDANGERED AND UNAVAILABLE SPECIES CAN BE SPECIFIED. SPECIFY REUSE OF EXISTING OR SALVAGED ITEMS IF RELEVANT.]

B. Where choices exist, preference is to be given to products and materials with [EDIT TO SUIT PROJECT] recycled content or resource efficient characteristics [EDIT TO SUIT PROJECT].

### **PART 3 EXECUTION**

#### **WASTE MANAGEMENT**

[CORRUGATED CARDBOARD IS ONE OF THE LARGEST SOURCES OF CONSTRUCTION WASTE. CHECK YOUR SPECIFIC PROJECT LOCATION FOR RECYCLING OPTIONS AND REGULATIONS.]

A. Separate corrugated cardboard in accordance with the Waste Management Plan and place in designated areas for recycling.

[WOOD IS ONE OF THE LARGEST SOURCES OF CONSTRUCTION WASTE. CHECK YOUR SPECIFIC PROJECT LOCATION FOR RECYCLING OPTIONS, MARKETS, AND REGULATIONS.]

B. Do not burn scrap at the project site.

C. Separate wood waste in accordance with the Waste Management Plan and place in designated areas in the following categories for recycling: [EDIT TO SUIT PROJECT AND LOCATION.]

1. Solid wood/ softwood/ hardwood. [EDIT TO SUIT PROJECT]
2. Composite wood, (for example, plywood, OSB, LVL, I-Joist, parallel strand, MDF, particleboard). [EDIT TO SUIT PROJECT]
3. Treated, painted, or contaminated wood.

D. Separate wood waste in accordance with the Waste Management Plan and place in designated areas in the following categories for re-use on site: [EDIT TO SUIT PROJECT]

1. Sheet materials larger than [2 square feet][SPECIFY SIZE].
2. Framing members larger than [24"][SPECIFY SIZE].
3. Multiple offcuts of any size larger than [12"][SPECIFY SIZE].

E. Set aside damaged wood for acceptable alternative uses, for example use as bracing, blocking, cripples, or ties.

F. Sequence work to minimize use of temporary HVAC to dry out building and control humidity.

G. Use the least toxic sealants, adhesives, sealers, and finishes necessary to comply with the requirements of this section.

#### **SPECIFIC SECTIONS**

[SECTIONS FOR WHICH THE SAME ADDITIONAL PROVISIONS ARE APPLICABLE ARE SHOWN GROUPED. INSERT THE FOLLOWING ADDITIONAL PROVISIONS UNDER PART 3 EXECUTION, WASTE MANAGEMENT, UNLESS OTHERWISE NOTED.]

#### **06100 ROUGH CARPENTRY**

#### **06170 PREFABRICATED STRUCTURAL WOOD**

#### **ENVIRONMENTAL CONSIDERATIONS**

[THIS IS AN APPROPRIATE LOCATION FOR ADDITIONAL LANGUAGE PERTAINING TO ENVIRONMENTAL ISSUES BEYOND THE SCOPE OF THIS WASTESPEC, SUCH AS THE FOLLOWING PROVISIONS.]

- A. Vertical studs to be of engineered wood, e.g., finger jointed studs.
- B. Beams and girders to be of engineered wood, e.g., LVL, parallel strand.
- C. Long span joists to be of engineered wood, e.g., wood I-joists, truss joists.

A. Store, protect, handle, and install prefabricated structural elements strictly in accordance with manufacturer's instructions. Keep products off the ground and protected. Pay particular attention to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements.

B. Fold up metal banding, flatten, and place in designated area for recycling.

C. Store separated reusable wood waste convenient to cutting station and area of work.

#### **06200 FINISH CARPENTRY**

## **06400 ARCHITECTURAL WOODWORK**

[SHOP FABRICATED AND PREFINISHED WORK, SPECIFIED IN SECTION 06400, CAN PROVIDE GREATER OPPORTUNITIES FOR WASTE REDUCTION AND ENVIRONMENTAL CONTROL THAN ON-SITE WORK.]

### **ENVIRONMENTAL CONSIDERATIONS**

[THIS IS AN APPROPRIATE LOCATION FOR ADDITIONAL LANGUAGE PERTAINING TO ENVIRONMENTAL ISSUES BEYOND THE SCOPE OF THIS WASTESPEC, SUCH AS THE FOLLOWING PROVISION.]

- A. All substrate materials to be manufactured without the use of urea formaldehyde additives or permanently sealed to prevent outgassing.
- A. Use non-toxic sealants, adhesives, sealers, and finishes.

## **06500 STRUCTURAL PLASTIC**

[THIS IS AN APROPRIATE SECTION TO SPECIFY PLASTICS WITH UP TO 100% RECYCLED CONTENT FOR LIMITED STRUCTURAL APPLICATIONS SUCH PLASTIC LUMBER FOR DECKING. CONTENT CAN INCLUDE PLASTIC, WOOD, AND OTHER FIBERS FROM POST-CONSUMER OR POST-INDUSTRIAL WASTE. CONTENT CAN BE TARGETED, E.G., MILK JUGS.]

- A. Set aside offcuts to be returned to manufacturer for recycling into new product. Place in designated area or provide for delivery to collection point. [USE WHEN SUPPLIER HAS RECYCLING PROGRAM.]

## **06600 PLASTIC FABRICATIONS**

[THIS IS AN APROPRIATE SECTION TO SPECIFY PLASTIC PANELS WITH UP TO 100% RECYCLED CONTENT. CONTENT CAN INCLUDE PLASTIC, WOOD, AND OTHER FIBERS FROM POST-CONSUMER OR POST-INDUSTRIAL WASTE. CONTENT CAN BE TARGETED, E.G., CARPET.]

- A. Set aside offcuts to be returned to manufacturer for recycling into new product. Place in designated area or provide for delivery to collection point. [USE WHEN SUPPLIER HAS RECYCLING PROGRAM.]

- END OF DIVISION -