RECYCLING CONSTRUCTION AND DEMOLITION WASTES

A Guide for Architects and Contractors

April 2005

Sponsored by:

The Boston Society of Architects
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With Support from:

Armstrong World Industries
Commercial Paving and Recycling Co.
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INTRODUCTION

This document has been produced for architects, engineers, specification writers, and contractors who have an interest in and understand the goals of job site recycling, but are not familiar with its practicalities. Without this familiarity, it's difficult to piece together how recycling works into overall project management, or to counter the concerns of those who object to job site recycling on the basis of cost, complexity, unreliability, or other factors. This document is intended to provide the information to understand and address those objections, and lay the foundation for successful recycling from any new construction, renovation or demolition project.

Why Recycle C&D Waste? "Sustainable building" has become a national catchphrase. In architects' offices and on construction sites around the country there's increasing emphasis on reducing the environmental impacts of renovation and new construction. Ranking systems like the U.S. Green Building Council's Leadership in Energy & Environmental Design (LEED) and Green Guidelines for Healthcare gain momentum from month to month.

Recycling Construction and Demolition Debris (C&D) recycling is one of the most important aspects of this movement. C&D recycling is among the most visible commitments a developer can make to sustainable building, visible to every worker on the site and to every passerby. In providing materials to local vendors and processors, job site recycling creates employment and economic activity that help sustain local economies. And perhaps most important, on a lifecycle basis, recycling produces usable materials at much less environmental cost than materials from primary sources. That is, in addition to conserving raw materials, recycling conserves energy and water, and reduces the production of greenhouse emissions and other pollutants. On and off the job site, recycling is one of the most significant commitments that can be made to sustainable building.

More practically, recycling is good for two or more LEED points. One LEED point is awarded for a recycling rate of 50%; a second for a recycling rate of 75%. Some waste reduction and recycling strategies (e.g., returning wastes to the jobsite in new products) can also qualify for additional innovation points. These are among the simplest and easily among the most cost effective LEED points in the book.

And in Massachusetts and Vermont, recycling is the law. In June 2004, Massachusetts proposed regulations that will ban the disposal of asphalt paving, brick, concrete, metal, and wood from solid waste handling facilities. And in Vermont, projects that require a state land use permit (Act 250 Permit) that are over 10,000 square feet are required to develop and file a waste reduction plan.

So for many reasons – environmental, economic, LEED-practical, and environmental compliance – job site recycling is, and should be, at the center of sustainable building.

*We also want to remind users of this document that recycling is only one of several ways to conserve resources and materials in construction and renovation. For every material that can be **re-used** in a job, recycling isn't even necessary. Ditto for **source reduction** – using less material in the first place, using less packaging, or using materials more efficiently (thereby eliminating waste). And finally, **use recycled or recycled-content products**. Recycling falls apart if there are no markets for the materials that are diverted from the waste stream, and the best way to assure strong markets is to specify the use of recycled products wherever possible.*

Contents:

In addition, ***Appendices*** to this Guide provide detailed information on recyclable materials, links to information on recycling haulers and markets, sample RFP/specification language that covers C&D recycling, and a template for a Waste Management Plan.

We would like to acknowledge the organizations that have provided additional financial support in the development and production of this *Guide*: Armstrong World Industries Commercial Ceiling Division, Commercial Paving and Recycling Co., LLC, ERRCO C&D Recycling, Gypsum Association, and Interface Flooring Systems. Each of these organizations has a recycling story to tell (see Part 5), and products that bring recycled materials back to the job site or otherwise contribute to job site waste reduction. Their contribution to making this document a reality is appreciated.

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This *Guide* is one of dozens of sources of information on construction and demolition recycling: web sites, books, guidance documents, sample management plans. It is our sincere hope that we have not simply duplicated information that you can find elsewhere, but created a document that is used often and is responsive to the needs of both architects and contractors doing business in the Massachusetts regional market. Reviewing the information overload that's already available, we concluded that a simple, short, comprehensible introduction to job site recycling was missing from the field – something that provides all the information you need to get started, but won't take a month to read and absorb. We hope that this guide fills that role.

PART ONE
THE NUTS AND BOLTS OF JOB SITE RECYCLING

WHY RECYCLE JOB SITE WASTES

The reasons to recycle construction and demolition (C&D) wastes are simple but compelling:

1. ***Construction and demolition wastes are one of the largest waste streams in the country.***
2. ***Almost all job site wastes are recyclable.***
3. ***It costs less – usually much less – to recycle job site wastes than to throw them away.***

One Of The Largest Waste Streams In The Country

Nationwide, it is estimated that as much as 40% of the raw materials consumed in the United States – steel, concrete, glass, and so on – are used in construction. When building stock turns over, all of these materials become waste. This C&D waste stream is enormous: about 130 million tons per year, or about 25% of all of the solid waste that is discarded in the United States.

This waste stream is also very large considered building-by building. The waste that's generated during construction of a new building is more than the occupants of that building are likely to throw out during one or two years of occupancy.

Almost All Job Site Wastes Are Recyclable

There is hardly a single waste material from a job site that cannot be recycled:

Architectural salvage:
- Doors and door frames
- Windows and frames
- Millwork

Ferrous Metals
- Structural steel
- Steel framing members

Non-Ferrous Metals
- Wiring/conduit
- Plumbing (pipes, fixtures)
- HVAC (ductwork, motors)

Ceiling tiles

Gypsum Wallboard

Furniture and Furnishings
- Office furniture
- Partition systems
- Medical/lab equipment
- Reception/casual furniture
- Lockers/athletic equipment

Carpeting
- Broadloom
- Carpet tiles

Roofing
- Shingles
- Commercial membrane
- Wood, metal, slate

Landclearing residuals
- Trees, stumps, brush
- Soil

Asphalt

Aggregate
- Concrete (with & without rebar)
- Brick
- Concrete block

Wood
- Dimensional lumber
- Panels (plywood, OSB, MDF)
- Engineered beams (glu-lam, etc.)

Porcelain fixtures

In total, from almost any job site, 90% to 95% of all waste materials can be recycled. Appendix A provides additional information on recyclable materials from the C&D waste stream.

There are some materials that aren't on this list, because markets remain undeveloped or contamination makes them difficult to recycle – for example, fiberglass and foam insulation, painted or papered gypsum wallboard. And some renovation or demolition job sites contain hazardous or special waste materials that need to be managed as such (lead-painted wood or plaster, asbestos floor tiles or siding).

Recycling Costs Less Than Throwing Away

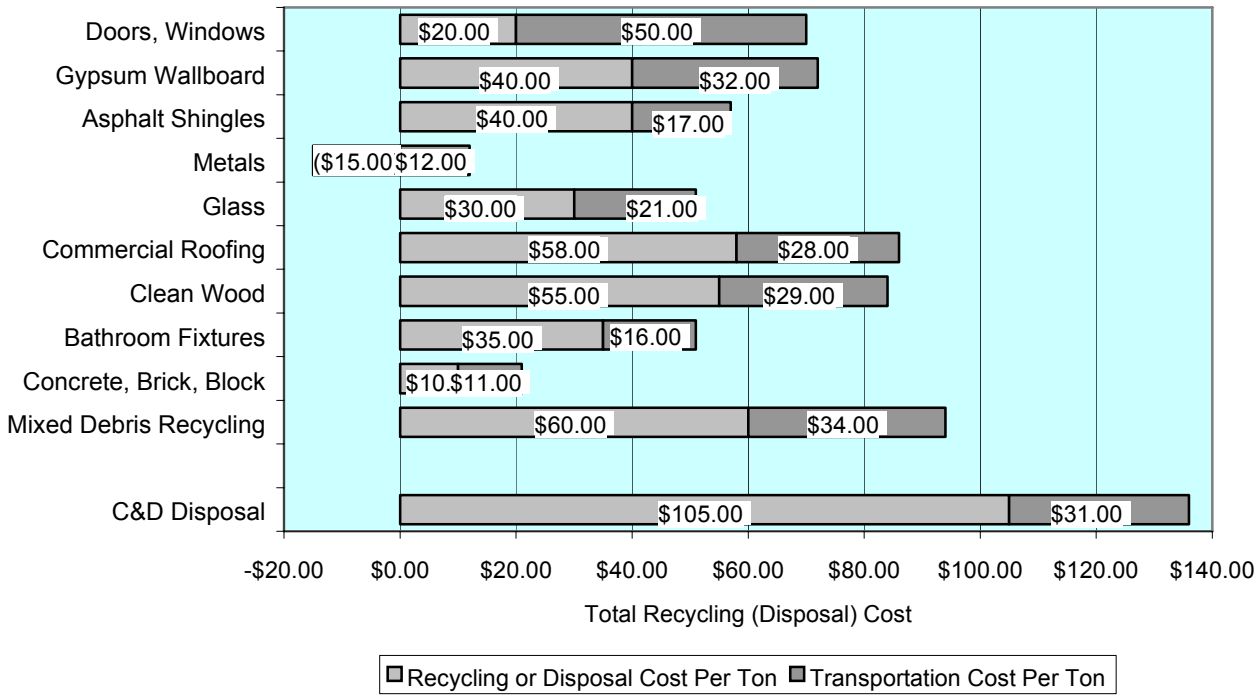
In almost all cases, the cost of recycling is lower than the cost of throwing materials away. Occasionally it's a near thing – a very small job, a tight site or schedule, an odd mix of materials. However, day in and day out, for the architect, owner, and contractor, recycling makes economic sense.

THE COST OF RECYCLING VERSUS DISPOSAL

This is a critical point. If recycling costs more than disposal, then there will always be a very good reason NOT to recycle. But if recycling is cost-competitive or less expensive than disposal, then recycling should be considered as part of every job.

Figure 1 presents the cost to recycle a variety of construction and demolition materials in the Boston area, compared to the cost of disposal. For each material, the total management cost, whether by disposal or recycling, has two components. The recycling cost is the cost per ton to process and recycle a material once it reaches a market (or, in the case of material that's disposed of, the landfill tipping fee). The transportation cost is the cost per ton to get a material to the market; this cost varies with the distance to market and with the quantity of material that can be hauled in a single load.

Figure 1
Boston Area Cost of C&D Recycling Vs Disposal
(Source: IRN Data)



As the graphic shows, the cost to recycle almost all C&D materials is much less than the cost to throw the same materials away. Take some of the highest tonnage materials in C&D: concrete, brick, and block. As a component of mixed debris, it costs about $105.00 per ton to dispose of these materials in a landfill, plus about $31.00 per ton for transportation to the landfill. If they're separated and recycled separately, the recycling charge is about $10.00 per ton, and the transportation cost is about $11.00 per ton. The total cost of recycling (the sum of the two bars, or $21.00/ton) is less than one-sixth of the cost of disposal. The story is similar for other common materials: wood, gypsum wallboard, metals, glass. In the worst case, the cost to recycle is not much more than half the cost of disposal. When you sum these costs across almost any construction project, the savings amount to thousands, and often to tens of thousands of dollars.

Even if materials cannot be separated for recycling, recycling still costs no more than disposal. At the bottom of Figure 1 is a direct comparison between the Boston area cost for recycling of mixed debris and the cost of disposal. The costs are about equal, with the great advantage, on the side of recycling, that 75% to 90% of the mixed debris gets sorted out, recovered, and used again.

"SOURCE SEPARATION" OR "COMMINGLED RECYCLING"

As Figure 1 shows, the economic benefits of recycling are highest if waste materials can be separated from each other and recycled individually. This is called "source separation."

Source separation means separating different recyclable materials ***at the job site***. That is, workers keep metals separate from wood, and wood separate from concrete, and so on, and place each material into a different container. These containers are then transported to different markets.

Commingled recycling is the alternative to source separation. Commingled recycling means placing all recyclable materials into a single container, which is then transported to a processing facility, where different materials are separated by hand or by automated equipment.

Source separation and commingled recycling have distinct advantages and disadvantages.

Advantages and Disadvantages of Source Separation vs Commingled Recycling

Recycling Method	Advantages	Disadvantages
Source Separation	• Higher recycling rates • Lower recycling costs; revenues paid for some materials • Often a cleaner, safer work site	• Multiple containers on site • Workers must separate materials for recycling • More complex logistics • Multiple markets; more information to manage
Commingled Recycling	• Only one or two containers on site • No need for workers to separate materials for recycling • Easier logistics • One market; less information to manage	• Lower recycling rates • Higher recycling costs

The biggest tradeoff between source separation and commingled recycling is complexity vs economics.

Source separation is more complex because workers must separate waste materials before they throw them away, there are more containers on site, and there are more markets and haulers to work with and keep track of.

But in most cases, *source separation is economically more advantageous* than commingled recycling:

- Source separation produces materials that are ready to go directly to market; there is no need to pay a processor to sort materials.
- Source separated materials are generally of higher quality, with fewer contaminants, so they're worth more in recycling markets.

On balance, ***source separation is generally preferable*** to commingled recycling. It costs less, and recycling rates are typically higher.

Complexity is usually not much of an issue. It's no harder for workers to toss different materials into different containers than to throw them out mixed together. Being smaller, containers for source separated materials can often be placed close to work areas, so that source separation actually takes less time and effort than carrying wastes to a central container for mixed debris (see Case Studies in Part 4).

Nor does source separation imply that every material will be separated all of the time. There will always be a mixed debris container on site, and there will be some materials that are always disposed or recycled as mixed debris. Some materials will also be source-separated during one phase of a job, but handled as mixed debris at other times. For example, in a wood-framed building, wood would generally be source-separated while the structure is framed. But when the project moves on and the only wood waste is an odd pallet or pieces of blocking, these will be handled as mixed debris.

There are some jobs where commingled recycling is the only option possible, because of site limitations, job size, or schedule. In these cases the goal is to identify the commingled processor who can achieve the best combination of price and recycling rate. But where it's feasible, source separation should be considered the best recycling option.

SOURCE SEPARATION PROCEDURES

The basics of source separation are easy: each recyclable material should be segregated as it is generated, and placed in the appropriate container.

A few additional rules make source separation work smoothly:

Keep as few containers as possible on site at any time. Containers take up space, and having too many containers increases the possibility of confusion and contamination. In general, aim to have one container on site for mixed debris, and one or two additional containers for the specific wastes generated during each phase of the job.

Match containers to the material. A wood container, for example, will typically hold 30 or 40 cubic yards. But scrap metal from wiring and plumbing may need only a 2- or 4-yard container. For something like concrete, you may have a lot of material, but container size may be limited by the weight that can be hauled over the road. Site layout and access also play a role in container selection.

Place containers close to work locations. An advantage of source separation is that it doesn't rely on one big central container for all wastes. Smaller containers can often be placed close to the work. Also look for opportunities to use intermediate containers like hampers or rolling hoppers that can be placed right next to the work, then wheeled to a larger waste container at the end of the shift. Again, there may be surprising savings in labor and convenience.

What makes source separation work is the fact that it's matched to the phase of the job. You only have on site the containers needed at a particular time for the specific wastes being generated. You collect, haul, and market these materials. When the job moves on, you recycle different materials, in different containers, and generally to different markets. It takes a little energy and thought to do this, but in most cases the financial savings and the advantage in recycling rates are more than worth it.

PLANNING AND THE WASTE MANAGEMENT PLAN

Good planning is the single most important part of construction waste management. Like anything else in construction, recycling is straightforward if you have a good blueprint, but becomes much more difficult and expensive if it's an add-on.

Good planning allows you to identify all recyclable materials and know how you're going to manage them before the job starts. Good planning addresses how each waste material will be handled, what containers will be used and when they'll be on site, and where each material will be marketed. Good planning allows you to assess the costs and benefits of recycling and decide which materials to source separate, which to recycle as commingled debris, and which to discard as trash. Good planning covers communications, training, and troubleshooting, and lays out tracking and reporting procedures for LEED or other documentation.

The Waste Management Plan is the document that lays out the start-to-finish strategy for job site recycling. It is prepared directly from the drawings and specifications for the job, and a good plan will closely follow these documents. The Waste Management Plan should:

- Estimate types and quantities of C&D wastes generated during each phase of the job;
- Identify how each waste will be managed and marketed;
- Provide an estimate of the overall job recycling rate;
- Lay out plans for training, meetings, and other communications related to job-site waste management;
- Provide troubleshooting instructions and contact information.

All of this can (and should) be done before you break ground, so that recycling is incorporated seamlessly into overall performance of the job. It's best if the Waste Management Plan is written and signed off on by all parties (owner, architect, contractor) a month or more before groundbreaking or the first day of demolition.

Because of its central role in construction waste management, more detailed information and a sample waste management plan are provided in Part Three, "The Waste Management Plan."

Ceiling tiles palletized and awaiting transportation

SPECIAL TOPIC: DEMOLITION AND RENOVATION

Demolition and renovation projects are different from new construction, and often need some extra planning. For example, compared to new construction, demolition and renovation projects often involve:

- Much larger quantities of waste (often the entire building);
- Many high-value wastes, for example, furniture and furnishings, architectural salvage, and valuable commodities such as nonferrous metals;
- Wastes that are difficult to separate and recycle (like painted gypsum wallboard, insulation, and shingles), and wastes that may be contaminated with hazardous materials.
- Automated demolition equipment like cranes and grapples, which don't lend themselves to the separation of one material from another.
- Tight and inflexible schedules; project value is in the new construction, while demolition is perceived simply as a cost, with the goal to finish as quickly and cheaply as possible.

In addition, some amount of recycling is already ingrained in the demolition industry. Demolition contractors have been segregating wastes for many years, either to capture revenue (e.g., wiring, structural steel), or to reduce disposal costs (e.g., concrete, brick). This is both good and bad. It's good because demolition contractors are already aware of and practice some recycling. It can be bad when a demolition contractor thinks he knows all there is to know about recycling, and balks at suggestions to go beyond customary procedures. Contractors who are generating revenues from recycling may also be reluctant to relinquish this income, as they may if a Waste Management Plan clearly identifies these materials and revenue streams.

Given these considerations, an ***on-site audit*** before work begins is a critical part of recycling from demolition or renovation. This is not necessary in new construction, where recycling can be planned entirely from drawings and specifications. A team that includes the architect, contractor, and recycler should get on site to confirm what materials will be removed and how they will be handled (hand disassembly, removal by crane, etc.). Often it will be good to bring along a salvage specialist, who can identify opportunities to remove architectural materials such as flooring, doors and windows. High-value commodities like wiring, nonferrous metals, suspended ceilings and the like should also be catalogued, and plans made for their recovery separate from other wastes. The on-site audit also provides an opportunity to identify and resolve any conflicts between recycling and operations – and more specifically, any potential conflicts between the owner, architect, and contractor, whose goals and priorities at this stage may not be completely in alignment.

CONTRACTOR, OWNER, AND ARCHITECT

C&D recycling is no different from any other aspect of performance on a construction project: A good relationship and understanding between the owner, architect, and general contractor are the most important part of making it work.

Understandably, it's the contractor who's often most concerned about recycling. The GC's job is to deliver a project on time and within budget. For the GC, trash has historically been a minor issue, an afterthought. Call a hauler, get some cans on site, pull them when they're full. Waste has been among the last and least of the contractor's concerns.

But recycling means real change. Recycling implies that wastes will be anticipated, managed, tracked. It implies that everyone on the job from the

project exec to the last hourly worker will have to know and do something different. It can mean more space tied up for containers, more traffic to and from the site, more possibilities for late deliveries or missed pickups. It means more relationships, more information, more paperwork, more costs to track and balance. It means the GC will have to learn new information, maybe a lot of new information, about a subject that has nothing to do with delivering a construction project.

It's no wonder many contractors hesitate, or find good reasons not to recycle.

To maintain the strength of the owner/architect/contractor relationship, it's important to have strong and clear communications between all parties on the job:

- It should be made clear that recycling is a critical and valued aspect of the GC's overall performance.
- It's important to communicate that the owner and architect understand the complexity of managing recyclable materials as commodities and not as wastes, and understand that this complexity has to be accounted for in project management.
- It's important to build a relationship in which it's clear that the owner, architect, and contractor share a common interest in waste management performance. The owner and/or architect should be familiar with recyclable materials, procedures, and markets, and should be able to suggest options and solutions.
- It's important to build in appropriate performance goals and guarantees. Recycling goals and standards should be made explicit in Requests for Proposals and other contract documents, along with reporting and recordkeeping requirements and expectations for recycling performance (see Appendix C). It should be made clear that the contractor will be recognized for solutions that go beyond minimum standards. And conversely, it should be made clear that sub-par performance will not be tolerated without clear explanation, with appropriate penalties included in contract language.

And finally, remember and take advantage of the fact that recycling is probably the most visible of all steps that can be taken toward sustainable building. Unlike energy efficient HVAC or certified forest products, recycling is something that everyone understands. On the job site, use this fact to generate teamwork and motivation among workers and subcontractors. For the local community, a placard on the perimeter fence that highlights recycling performance is a great public relations tool, and a press release on recycling will almost always get picked up by local media. If you turn recycling into a shared mission that heightens camaraderie and teamwork among everyone on the job – GC, subcontractors, workers, architect, and owner – you can gain benefits that go far beyond the calculation of a recycling rate.

HAULERS AND MARKETS

Haulers and markets are the most obvious and critical link in job site recycling. Without markets, recyclable materials are trash. Without haulers, recyclable materials are trash on the ground with nowhere to go.

The best news in C&D recycling, and one thing that's really changed in the past five years, is the great increase in the number and variety of recycling markets, and the number of haulers willing to handle C&D wastes. A few years ago, in the Boston area, there was one mixed debris recycler and (outside of the metal scrappers) perhaps a half dozen firms who offered recycling for a limited selection of source separated materials. There were perhaps the same number of haulers who offered the flexibility to handle C&D for recycling.

Now, the number of C&D recycling markets has increased dramatically, and continues to increase. With many options now available, it's important to know what you're looking for in a hauler or end market for recycled commodities. A checklist is provided on the next page.

There are many sources of information on recycling markets and haulers. Most of the New England states' environmental agencies collect and post information to their web sites on solid waste haulers, and most also list markets for construction and demolition materials and other recyclables. Appendix B provides links to state-maintained and other generally reliable listings of haulers and recyclers.

It's rare and not really necessary for the architect or owner to track and evaluate all of the hauling and market options for 20 or more recyclable commodities. That task is best handled by the general contractor, who has on-site waste management responsibility, or a firm that specializes in managing and recycling job site wastes. It ***is*** important, however, for the architect and owner to have a general familiarity with waste haulers and markets, in order to participate productively in planning and evaluating job site recycling options with the rest of the project team.

TRAINING

There's a simple rule in C&D recycling (which is the same as a simple rule in architecture and construction): If it doesn't meet specified requirements, it costs money to fix.

Recyclers are set up to handle specific materials: wood, metal, gypsum wallboard, etc. If a load comes to their facility that's mixed with other materials, that's a problem that can increase recycling costs. Either the contaminating material has to be separated out, or the quality of the recycled product will be downgraded , or the entire load will be rejected and disposed of – all of which add cost that will be passed back to the contractor. It's much easier and less expensive to meet the specification in the first place. That means training.

Training need not be extensive, time consuming or complicated. For the most part, it consists of one lesson: "If it's X, it goes in the X box. If it's Y, it goes in the Y box. If you have questions, ask your supervisor."

There are just a couple of other things to be added to this lesson, like:

"It is important to do this. This is one of our major environmental commitments on this job."

"It is important to do this. If you do not do this it will cost us a lot of money."

"It is important to do this. If you do not do this you will have to go into the dumpster and get it right."

There are times when more instruction is needed. For example, if you're using hoppers or hampers close to work locations, workers will need to be instructed to use these containers, where to take them at the end of the shift, and where and how to empty them. If workers have to unscrew ballasts from fluorescent light fixtures, or take care not to destroy wood flooring when it's being removed, they'll also need the appropriate training. But most recycling is simple, and the training should be kept simple, too.

Training should be provided every time one subcontractor crew switches out for another. It's most important that every worker who is regularly on the site and handling a recyclable material should receive some training.

Signage. Another part of training is signage. Basically, each waste container should have a big sign that says: "RECYCLING. METAL ONLY" (with different material names as appropriate).

A problem with signs: they often disappear down the highway when a container gets pulled. This is particularly true with flat magnetic signs, which otherwise make a lot of sense on dumpsters and rolloffs. One alternative is free-standing signs on posts welded into tire rims (which work great until the wrong sign gets parked next to the wrong container). Another effective solution is to rig signs that hang over the rim of a container. Compared to magnetic signs, it's more obvious that they're temporary and not permanently fixed to the container, and it's hard for a driver to miss them when he's checking his load before pulling away.

TROUBLESHOOTING

Like anything on a construction site, everything goes fine when everything goes fine, but you need someone to call when something goes wrong.

- The container's full and the truck doesn't show up.
- The container has to be moved so the crane can get in behind it.
- There's cardboard in the wood box and the driver refuses to haul it.
- Can a glu-lam beam go in with dimensional lumber?
- It's going to rain tonight and the wallboard container is only half full.
- Lots of nails and tarpaper are coming off with the shingles. Can they all be recycled together?
- Workers keep throwing lunch wrappers in the metal box.

Every construction recycling site should have one person (with a backup) who knows everything that's going on, waste-wise, and has ultimate responsibility for making it go right. Just as the GC and each subcontractor have a supervisor, there should be a recycling supervisor as well. This can be a contractor employee, or someone hired by the contractor. This person need not be on site all the time, but he or she should come to the site regularly to check on progress and answer questions; he/she should also be present to listen and provide input at project oversight meetings. Generally, this should also be the person who's prepared the waste management plan and made the hauling and marketing arrangements for the job, who provides training when there's a change of subcontractor crews, and who's responsible for waste tracking and reporting. In other words, all these reins should come together in one set of hands, in a person who's able to understand and respond to every recycling contingency that comes up.

WHAT TO LOOK FOR IN A HAULER FOR RECYCLED MATERIALS	
_____	Flexibility: Do they offer different types of containers and vehicles for different recycled materials? How many trucks and how many containers do they have?
_____	Flexibility: How many of your needs do they meet? The fewer haulers you rely on, the better.
_____	Flexibility: Will they be there when you need them, even for off-hours pickups? What's their response time?
_____	Market Relationships: Are they tied to only one or a few markets, or do they work with many markets? Will they work with markets that you identify?
_____	Market Relationships: Are they able to suggest markets that you didn't know about?
_____	Reliability: Check with other people they've worked with. Do they show up on time, and call if there are going to be any problems?
_____	Reliability: Will they give you a number and contact to call, one you can be sure you can reach, if anything goes wrong?
_____	Reliability: Do they have backup if a truck or another piece of equipment breaks down?
_____	Location: Where are they located compared to the job site and to markets? Longer hauls mean more cost and more possibilities for things to go wrong?
_____	Cost: What is their price structure? Be sure to comparison shop, because proposed rates can vary by 30% or 40% for the same haul. (And always ask if they can do better.)
_____	Safety: Ask for documentation of safety and driving violations.
WHAT TO LOOK FOR IN A MARKET FOR A RECYCLED MATERIAL(S)	
_____	Process and End Products: Be sure you're comfortable that their recycling process and products are in line with your own recycling and environmental goals. Particularly with mixed debris recycling, there are some processes that are just another route to landfill, and some "recyclers" who don't get much of a recycling rate (see Section 5).
_____	Materials: How many do they handle? All other things being equal, you'd prefer to deal with fewer markets. But markets that specialize in one or a few commodities often offer the best service and/or prices. Be sure to shop and compare.
_____	Hauling: Will they haul as well as provide a market?
_____	Pricing: How do they compare to other markets for the same materials?
_____	Pricing: Do they return revenues for materials like metals? Are prices tied to published indexes?
_____	Pricing: For positive revenue items like metals, how quickly do they pay? Ask for references from other customers.
_____	Financial History: Check credit references and other sources of information to verify stability.
_____	Tracking/Reporting: Confirm that they can and will provide weight slips, certificates of recycling, or other documentation you need to confirm recycling quantities, rates, and ultimate end uses.
_____	Location: Where are they in relation to your job site? Long hauls cost a lot of money.
_____	Safety and Environmental Record: Do an on-site audit. Look for safety and environmental issues (availability of safety equipment, general neatness, attitudes toward safety/environment, etc.)
_____	Safety and Environmental Record: Know what permits are required, and ask to see them.
_____	Safety and Environmental Record: Check with state regulators for any violations.
_____	Insurance: If something goes wrong, liability flows back to you. Confirm that insurance is in place, adequate, and paid up.

PART TWO
BARRIERS AND SOLUTIONS

Almost every day, somewhere in New England, an owner, architect, or contractor is proposing to recycle construction and demolition wastes. And almost every day, someone else is throwing up a barrier to recycling. Unless the proponent can address each barrier, recycling will often be abandoned before it's tried. Or worse, it will be forced on an unwilling participant who will, with or without actual malice, find a way to torpedo the effort. It's far better to address the barriers up front, with real information, than let them stand in the way, or linger and taint the whole recycling effort.

RECYCLING WILL SLOW DOWN THE JOB

The perception that recycling will slow down the job is almost never true. Recycling asks workers to work a little bit smarter, not any harder or longer. Recycling containers are matched to the specific wastes being generated during different phases of the project, and they should be clearly labeled, so there's not a question of having to choose which container to use for which waste. Because they're often smaller than the big rolloff boxes used for mixed debris, many recycling containers can be placed closer to the work locations where wastes are generated. Far from slowing down the job, recycling often saves time and effort.

(There's also a safety connection. Because recyclable wastes are usually put into containers as soon as they're generated – not left on the ground to be picked up as mixed debris – recycling generally makes for a cleaner and safer job site.)

In addition, recycling is a morale booster. Recycling gets strong support from contractor and subcontractor work crews. This means that they give extra effort to make recycling work, and enhances the overall tone on the work site, which makes the work go smoother and quicker.

Logistics and service are other reasons which suggest that recycling might slow down the job. Again, this is not true. The key is to integrate recycling with other job site activities, so that the right containers are on site for each phase of the job, and containers flow smoothly onto and away from the site as wastes are generated. If this is done, there's no reason that recycling a half dozen different materials will take any more time than throwing everything away into a single dumpster.

THERE'S NO ROOM ON SITE TO RECYCLE

This, too, is almost never true. A key to successful recycling is to match containers to wastes, both in time and size. So it's not necessary to have five or six containers on site. Instead, containers are matched to each phase of the job, and are swapped in or out so that only one to three containers are on location at any time, matched to specific wastes being generated.

Also, because recycling containers are often smaller than mixed debris containers, there can be more flexibility in setting them out on the site, so that a recycling container can often be shoe-horned in where a larger mixed debris container would not fit.

If site constraints absolutely preclude source separation, sorting wastes off site is an option, although one that will add labor and other expense. And mixed debris recycling, with recycling rates of 75+% (see Section 5) should be possible on any jobsite.

WITH ALL THESE CONTAINERS AND MATERIALS, RECYCLING IS WAY TOO COMPLICATED

More complicated than having one big container for all job site wastes, yes. But really complicated? Hardly.

What recycling requires is intelligent up-front planning, most of which is already done as part of overall project management. The waste management plan tracks the flow of the project, matching the work that's being done as the project moves from phase to phase. When the framers are working, it's time for a wood box. When the wiring, plumbing, and HVAC are being installed, it's time for a metal box. When gypsum wallboard is being installed, it's time for a wallboard box. If you've planned the job well from the construction side, you've already done most of the work required to recycle.

BUT HOW DO I KNOW ALL THESE SERVICE PROVIDERS WILL BE RELIABLE?

Until the mid-1990s, this was a good question. There were many fewer recycling markets, and only a few haulers who made C&D recycling a priority.

But this situation has changed rapidly, thanks to the basic laws of supply and demand. As more owners, architects, and contractors have begun to ask for recycling services, more service providers have entered the market, and to survive they've had to offer efficient and reliable service.

Now, it's no different than choosing any other subcontractor. Confirm references from past work; look for size, flexibility and stability; do a basic background check; and make sure you have a dedicated contact who's accountable for each job (see the hauler and market checklist in Part 1). If you do this, reliability shouldn't be a question.

WE HAVE NO RFP OR CONTRACT LANGUAGE FOR RECYCLING

C&D recycling starts with a good specification that clearly states recycling goals, materials to be recycled, and planning, reporting, and recordkeeping requirements. As with every other jobsite activity, a good specification provides the foundation for a smooth work flow, without confusion or misunderstanding. Recycling shouldn't be an afterthought or add-on.

Just a couple of years ago, a lot of C&D recycling specs had to be written from scratch; there just weren't many examples to go by. But now there are a lot of good samples to choose from, that fit just about every recycling situation and specification format. Appendix C provides two model specifications, and there are many more available over the web. Several of these sources are also listed in Appendix C.

RECYCLING COSTS TOO MUCH

After everything is said and done, this is the biggest reservation that owners, architects, and contractors express about recycling.

It's also one of the easiest to disprove. Throughout New England, the cost to landfill C&D wastes tops $80.00 per ton. In many locations, the cost is over $100.00 per ton. Transportation charges generally add another $30 to $40 per ton, so that total cost to dispose of C&D waste in most of New England ranges from $110 to $140 per ton.

The difference between this cost and the cost of recycling, for almost every recyclable material, is dramatic. Figure 1 (in Part 1) documented this fact. Although exact pricing varies with markets and transportation lanes, the financial information is clear and compelling: ton for ton, for almost every material in the C&D waste stream, recycling is much less expensive than disposal. And for the highest volume materials in C&D, recycling is less expensive by a factor of two, three, or four.

The case studies in Section 4 provide specific documentation of savings achieved on jobsites where multiple materials were recycled.

In a worst case scenario – a tough site, a tight schedule, a waste stream that has to be recycled largely as mixed debris – it's safe to state that recycling will cost no more than disposal. In almost all other cases, recycling will be much less costly, with savings that often run into tens of thousands of dollars, even after all costs for planning, training, recordkeeping, and reporting are factored in.

I'LL NEVER GET SUBCONTRACTORS TO GO ALONG

Subs respond to the same cues as anyone else: clear priorities, clear instruction, clear procedures, financial penalties and incentives.

Two things are most important:

1. ***Management-level interaction:*** Make sure that subs' managers and supervisors understand that recycling is important and that deviation from specified procedures will be penalized. Again, clear up-front specifications and unambiguous contract language are critical.
2. ***Training:*** Recycling training should be provided at every crew shift, and should cover materials to be recycled, recycling procedures, recycling containers (location, identification, etc.), and where to go with questions. It's particularly important to reach subcontractor supervisors, so that they can provide instruction to individual workers as they come onto the site from day to day.

Subs and their workers understand the environmental importance of recycling, and tend to be supportive. Their concerns are predictable: "It will slow us down." "It will cost us." "It's complicated." As long as procedures are clear and these concerns are answered, compliance with recycling requirements should not be an issue.

THIS IS A UNION JOB. THE UNION WON'T COOPERATE, AND THE LABOR COST WILL BE TOO HIGH

In almost all cases, the reverse will be true. Unions and their workers understand the environmental benefits of jobsite recycling, and see a commitment to recycling as a commitment to caring by the owner and contractor. Union employees are often the most enthusiastic supporters of recycling.

As noted elsewhere, there's no reason to expect that recycling will add significant labor time or cost into the job, and in many cases recycling can save some time in waste management. Recycling also promotes a neater, safer, and more productive jobsite. Again, these are factors that will encourage union support, not the reverse.

It is important to bring union reps into the planning process and solicit their input and comment on waste management and recycling. After all, the workers on the jobsite are where the rubber meets the road, and they more than anyone else have to integrate recycling into the job flow. Getting their early involvement and support is an important step.

PART THREE
THE WASTE MANAGEMENT PLAN

The Waste Management Plan is the cornerstone for successful C&D recycling. It is a comprehensive document that provides all of the information needed by any individual on site to understand and achieve the waste management goals for the project.

The Waste Management Plan should be started as early in the project as possible, well before groundbreaking or the beginning of demolition. This allows time for all parties to participate in developing the plan, allows contractors and subcontractors to integrate recycling into their setup and work plans, and assures that training can be provided to supervisors and workers. If there will be issues like space for recycling containers or internal handling of recyclables (e.g., using hampers or self-dumping hoppers), these definitely should be addressed in the Plan well in advance of groundbreaking.

The Waste Management Plan is also a living document, used as a day-to-day reference just like blueprints and specifications. This fact cannot be overemphasized. Handling procedures or markets may change during the course of a job; these changes should be noted in modifications to the plan. As waste materials move from the site you will gather information on waste and recycling tonnages and costs. These should be matched against initial projections, variances should be analyzed, and a running recycling rate should be calculated. This last is critical. If you're looking for LEED points or other certification, you need to track progress toward this goal (and take steps if it looks like you're running low). And you should publicize the recycling rate to laborers and trades; it's a good way to help boost morale, and keep workers striving to achieve your recycling goals.

The Waste Management Plan should include the following information, laid out in clearly identified sections. A sample waste management plan is included as Appendix D.

Section 1: CONTACT INFORMATION

Contacts for all persons with responsibility for waste management, including, at a minimum, architect, general contractor (project manager and site supervisor), and waste management specialist (if one is engaged for the project). Also, in some cases, owner's representative, waste hauler(s), and key subcontractors (e.g., demolition subcontractor).

Section 2: GOALS

This is a critical – if brief – section and should be placed front and center. It states in concise but explicit terms the waste management goals for the project. For example, "This project will recycle, reuse, or salvage at least 75% of the waste generated on site to earn 2 LEED points." Important sub-goals should also be stated clearly, such as, "Documentation of all wastes leaving the site shall be maintained by the site supervisor, including wastes removed from the site by subcontractors." The Goals section makes clear, to all who read it, the importance of waste reduction and recycling, specific goals, and the most important activities and responsibilities that support achievement of these goals.

Section 3: TRAINING

It's important that all contractor and subcontractor employees receive training in jobsite recycling procedures. They are the individuals who will place wastes in either the right (that is, the recycling) or the wrong (the trash) container.

The training section of the Waste Management Plan lays out the procedures to assure that all workers and supervisors receive training, and outlines the contents of training. Typically, training will be keyed to three events:

Crew shifts. When the job moves to a new phase with a new set of subcontractors on site, training should be provided to subcontractor supervisors and personnel. Whenever possible, training should be provided directly to all laborers. If not, the responsibility of subcontractor supervisors to provide training should be made clear, and they should be required to document that training has been provided to their crews.

New subcontractor on site. Every time a new subcontractor comes on site, the subcontractor's supervisors and key staff should be trained in jobsite recycling procedures, including communications, troubleshooting, and penalties.

Weekly meetings. Weekly construction project meetings should include a recycling "freshener", including updates on recycling rates, notes of any changes in recycling procedures, troubleshooting, and time for questions and answers.

Section 4: COMMUNICATIONS AND TROUBLESHOOTING

Communications includes:

Meetings: At what meetings will waste management and recycling be discussed? What is their schedule? Who will attend? What information will be discussed.?

Typically recycling is addressed in most pre-construction meetings and in meetings at subcontractor changeover or the introduction of a new subcontractor. Some contractors, owners, or architects ask for a recycling update at all weekly meetings.

In general, recycling meetings can be keyed to the complexity and phase of the job. A complex job (or any job in a complex or rapidly changing phase) may require frequent attention to recycling in jobsite meetings. A smaller or simpler job, or any job in the middle of a long, stable phase of construction, may require only infrequent discussion of recycling.

Questions and Decision-making. The communications section also specifies who is responsible for decisions related to recycling, the chain of command for such decisions, and who should be contacted with recycling questions as they arise.

Troubleshooting. Like any process during construction, recycling can encounter problems – a container in the wrong location, a missed pickup, an engine block in the wood dumpster. The troubleshooting section specifies the steps to be taken and individuals to be contacted in the event of such situations. Most important is that persons using the plan – the site supervisor and key subcontractor personnel – know what steps to take (generally, "STOP") and whom to call if an unexpected problem comes up.

Section 5: REPORTING AND RECORDKEEPING

It's impossible to prove the value of waste reduction and recycling – either financially or environmentally – without good documentation. This means (1) a comprehensive and verifiable record (by weight) of all materials that leave the site, either as trash or recyclables;
(2) documentation of where these materials have been sent; and
(3) information on the costs of hauling and disposing of all wastes and recyclables.

The Waste Management Plan needs to spell out procedures to collect and manage this information. Four items are critical.

1. Weight slips: Obtained from haulers or end markets, for each container that leaves the site.
2. Documentation of recycling (or disposal): Obtained from all end markets (in many cases, weight slips are adequate to provide this documentation).
3. Transportation invoices: Obtained from haulers or markets (in cases where transportation is provided by the market).
4. Recycling/disposal invoices/receipts: Obtained from end markets.

The Waste Management Plan should specify who is responsible for acquiring and storing this information, where information will be stored (e.g., on site, by the architect, by the contractor), who is responsible for using the information to produce operating and financial reports (including LEED or other documentation), and how information will be transferred from one party to another.

A few waste streams need special consideration. The Waste Management Plan should include instruction on how documentation of these wastes should be handled:

- Furniture and furnishings: These typically aren't recorded by weight. Conversion from a piece count to a weight estimate is required.
- Equipment that is resold: Items that are sold or donated to secondary markets are rarely weighed. These may include, for example, chillers, air conditioning or ventilation units, kitchen equipment or industrial machinery. Again, a reasonable weight estimate is required.
- Items recycled by subcontractors: Many scrap metals have significant market value, and subcontractors are used to carrying them off on their own. Contractors who may do this include plumbers, electricians, HVAC contractors, and roofers. It's not necessary to interfere with this practice; simply require that subcontractors report on the materials they take off site. (Unless there's a lot of tonnage involved, you don't have to require weight slips; subcontractors' estimates are sufficient.)

Section 6: WASTE IDENTIFICATION, MANAGEMENT, AND MARKETING

This section is the core of the Waste Management Plan. Material by material, it catalogues what will be generated as waste from project start to finish, how each material will be handled (source-separated recycling, commingled recycling, or disposal), and where each material will be marketed (or disposed of).

The section can be less or more comprehensive. A simple project that generates only a few waste materials may need only a few lines of information. A 400,000 square foot renovation may have 20 pages of detail. The aim is to assure that anyone who comes on site and generates a waste can find that waste in the plan and find out what to do with it.

For each waste, the management plan should include the following information:

Material: Described in enough detail so that each waste material can be identified without ambiguity. It's critical that the roster of materials is comprehensive; if you omit a significant waste stream, it may cause confusion on the job site, and may seriously affect your ultimate recycling rate and waste management costs. It's most important to list separately all materials that will be handled differently or will be sent to different markets. For example, if all metals will be placed in a single container and marketed together, it may be sufficient to list "Metals" in the plan, with the accompanying information that any and all metals are to be treated in the same way. But if, for example, ferrous and nonferrous metals are to be separated and marketed independently, the waste management plan should specify this separation and independent handling procedures.

Procedure: How will materials be handled? Many jobs may have only three categories: (1) source-separated recycling; (2) commingled recycling; and (3) disposal as waste. Other categories (not necessarily a comprehensive list) include recovery as salvage (e.g., furniture and furnishings), on-site or off-site grinding (e.g., landclearing debris) or crushing (e.g., concrete), or on-site stockpiling (e.g., soils).

Market: This field lists the specific organization that will receive each recycled material. No waste is recycled until it's marketed, and no material should be targeted for recycling until (a) a market has been identified, (b) you've confirmed that the market will accept the material, and (c) confirmed that you can meet the market specification for the material. Don't fill in the "Market" until you've made these checks.

Estimated Quantity: As the plan is developed, quantities of each waste should be estimated and recorded as an aid in planning container number and size, estimating the project recycling rate, and estimating waste management costs.

Section 7:
RECYCLING RATE ESTIMATE

This calculation encapsulates your estimates of the total quantities of materials recycled and the total disposed . The recycling rate is simply the total quantity recycled divided by the sum of the quantity recycled plus the quantity thrown away.

When the plan is first developed, this will be an estimate, used to forecast an ultimate recycling rate and to assess changes in waste management procedures that will affect this rate. As the project moves along, it becomes a living record used to track progress toward recycling goals. If the rate runs below projections, use the results documented in the plan to find out why, and (particularly if you need a specific rate for LEED or other certification) use the plan to evaluate alternatives to increase the rate.

Section 8: COST/BENEFIT ASSESSMENT

As noted elsewhere, it's a rare project where recycling is undertaken for strictly environmental reasons. Recycling needs to be justified financially, as well as environmentally. This section of the plan – typically a worksheet – is where you make this justification.

As you develop the plan and identify markets, you'll be able to estimate recycling costs, material by material, for transportation (including containers) and management. You should simultaneously estimate the cost to dispose of materials as wastes (transportation plus tipping fee), so that you can compare the cost of recycling versus disposal.

Once again, these are estimates that should be updated with real information as the project moves ahead, so you can compare actual against budgeted waste management costs, and keep a running track of the savings for recycling compared to disposal. This is another good morale builder for workers on site, as well as a nice Good News item for contractor management, architect, and owner.

PART FOUR
CASE STUDIES IN CONSTRUCTION AND DEMOLITION WASTE REDUCTION

Case Study 1
DOUGLAS SCHOOL RENOVATION / NEW CONSTRUCTION, DOUGLAS, MASSACHUSETTS

Photo: Blind Dog Photo

This case study is one in a series developed by Massachusetts Department of Environmental Protection (DEP) to highlight techniques for saving money and protecting the environment through reuse and recycling of construction and demolition debris. Additional information can be found on the Mass DEP web site on Construction and Demolition Materials (www.state.ma.us/dep/recycle/recycle.htm), including additional case studies, model specifications, recycling companies and information on best practices.

Summary:

Project: 137,000 sft new construction plus 6,800 sft renovation and addition; rural location; public owner
Total Waste Reduction: 57% (444 tons recycled, 338 tons disposed)
Cost Savings: $31,812, or 66%

Project Description

Consigli Construction Inc. was the lead contractor for the Douglas School project. The brick structure is located on a wooded hillside in a rural area. While a small portion of Consigli's work on the project was renovation and addition, most of the project consisted of construction of a new high school -- a two-story building designed for 700 students, grades 7-12.

Spotlight: Gypsum Wallboard

Consigli used a combination of contract requirements, a worksite management plan and techniques to have its subcontractors to source-separate approximately 50 tons of clean new scrap gypsum wallboard from construction debris. Placing recycling containers throughout the construction site and putting disposal containers further away increased source separation by making it more convenient for workers to recycle than to discard recyclable materials. Workers collected the materials on a regular basis and kept the wallboard dry and stacked flat in a closed container. Consigli transported the scrap wallboard 100 miles to G-P Gypsum Corporation in Newington, New Hampshire. G-P accepts both interior and exterior clean new scrap gypsum wallboard and makes it into new wallboard.

Cost Savings

The following table breaks down the cost savings achieved through source separation and recycling.

Material	Tons	Recycling Cost	Avoided Disposal Cost*	Savings
Concrete	285	$8,265	$31,065	$22,800
Metal	69	$1,380	$7,521	$6,141
Wallboard	49	$2,559	$5,450	$2,891
Cardboard	0.67	$67	$70	$3
Wood	40	$4,381	$4,358	($23)
TOTALS	**443.67**	**$16,652**	**$48,464**	**$31,812**

Keys to Success: Oversight of Recycling

Contracting

- Tie the subcontract language to a waste management plan that requires recycling, specifies recycling techniques, and provides incentives for recycling.
- Negotiate disposal fees by type of material to reduce costs based on the market value of the material rather than paying a flat fee for all materials.
- Verify that recyclable materials are brought to a recycler by requiring that the subcontractor provide "weight slips" from a recycling facility.

Planning. Develop and distribute a waste management plan prior to project initiation. Discuss waste handling requirements with crew and subcontractors before beginning a project and continue to emphasize their importance as work progresses.

Construction. Monitor the recycling bins to prevent cross contamination. Post lists of what is and is not recyclable on the containers.

- Place smaller recycling containers closer to the workers and aggregate materials in a common recycling and disposal storage area.
- Under the management plan, a foreman monitors the recycling and disposal activity for each trade.

Post Construction. Conduct a cost-benefit analysis of recycling to evaluate savings.

- Evaluate the impact of recycling on job safety and scheduling milestones. Consigli found that the waste reduction planning process made for a cleaner and safer site. A more intensive focus on scheduling recycling and disposal hauling created greater efficiencies.

Project Team

Building Owner	Town of Douglas, Davis Street, Douglas, MA 01516
General Contractor	Consigli Construction Inc.,197 Main Street, Milford, MA 01757, Telephone: (508) 473-2580. Contact: John Tessicini

Case Study 2
BOSTON SCIENTIFIC COMPANY, INC. (BSCI), OFFICE PARK RENOVATION, MARLBOROUGH, MA

Summary

BSCI undertook the renovation of a two-story, 30,000 square-foot office building as Phase 1 of a 2-building, 400,000 sq ft project. The general contractor was Payton Construction Corp.; SOS Corp. was demolition subcontractor. The project involved gutting and replacement of interior furnishings and fittings, wall/partition systems, HVAC, electrical, plumbing, and membrane roof. The project was particularly complex because renovation began at the same time as demolition, so that employees could move into parts of the building while other areas were still in construction. The project was carried out to LEED Silver.

Project: 30,000 sq ft renovation; exurban location; private owner
Total Waste Reduction: 92% (702 tons recycled, 62 tons disposed)
Cost Savings: $49,983, or 63%

Spotlight: Mobile Hampers Improve Material Handling and Flow

Loading dock space was a particular problem, with only two dock slots which had to be reserved for the receipt of new materials as well as all outbound shipments. This was the only location from which wastes could be shipped. The large footprint also entailed long carry distances from locations where wastes were generated.

Payton and SOS addressed this problem by mobilizing over 200 wheeled, soft-sided hampers holding 15-20 bushels (about 1 cy) of wastes, along with four-wheeled rigid dollies to handle bulky materials like studs and partitions. These were spotted at individual work locations, where employees deposited specific wastes into designated containers. Full hampers or dollies were wheeled and staged in the shipping/receiving area. When wastes accumulated in a quantity to fill a dumpster or rolloff, the appropriate container was brought to the dock, loaded, and removed, taking up dock space only for the short time needed to fill the container. Using the hampers and dollies also made for a very clean work site; because wastes were picked up as they were generated, with none left on the floor for later collection.

Cost Savings

The following table documents the cost savings achieved through source separation and recycling:

Material	Tons	Recycling Cost	Avoided Disposal Cost	Savings
Furnishings	470	$0	$37,125	$37,125
Wallboard Partitions	93	$8,000	$12,787	$4,787
Metals	65	$0	$8,125	$8,125
Wire and Cable	10	$0	$1,250	$1,250
Ceiling Tiles	19	$4,980	$5,706	$726
Plate Glass	2	$0	$300	$300
Mixed Debris to Recycling	43	$8,242	$5,912	($2,330)
Recycling Totals	**702**	**$21,222**	**$71,205**	**$49,983**
Mixed Debris to Disposal	62			
Project Recycling Rate	**92%**			

Keys to Success: Flexibility and Cooperation

Although careful and early planning is generally a key to successful recycling, this project demonstrates that it's not always necessary. The decision to pursue LEED certification was made when demolition was practically underway. Flexibility and cooperation from all parties to achieve this goal were critical to successful recycling.

Owner, Contractor, and Union Support

- If the owner makes an active commitment to recycling and maintains interest and involvement throughout, it's a lot easier to bring along the participation of contractors, subcontractors, and their employees.
- Involvement and support from the GC's on-site managers are critical. If they are committed to recycling, this commitment filters down to everyone else on the site.
- Union representatives can play a key role in recycling success. If they understand the rationale and goals for recycling, and understand that recycling can make work simpler and more rewarding, they will generally jump on board, as they did at BSCI.

On-Site Presence. Make sure the recycling coordinator is a visible member of the project management team and is frequently on site. This reinforces the importance of recycling, and assures that recycling questions and issues can be addressed as they come up.

Training and Communications. Make sure that everyone who comes to work on the site receives proper instruction in recycling goals and procedures, knows how materials are to be separated and handled, and knows whom to contact with questions.

Shifting on the Fly. With a tight time line, you can't always be locked into pre-existing plans, markets, or hauling arrangements. Be willing and ready to identify new outlets for nontraditional materials, shift markets to optimize recycling rates or costs, or bring in a new hauler who can respond to particular needs as they change over time.

Project Team

Building Owner: Boston Scientific Company, Inc., One Boston Scientific Place, Natick, MA 01760-1537.

General Contractor: Payton Construction Corporation, 273 Summer St., Boston, MA 02210. Telephone 617-423-9035. Contact: Dan McDavitt, Director of Safety/LEED Accredited Professional (email dmcdavitt@payton-construction.com).

Demolition Subcontractor: SOS Corp., 331 West Street, Milford, MA 01757. Telephone 508-473-0466. Web: www.soscorp.net. Contact: Charles Bjornson (email cbjornson@soscorp.net).

Recycling Consultant: The Institution Recycling Network, 7 South State Street, Concord, NH 03301. Telephone 603-229-1960. Web: www.WasteMiser.com. Email info@ir-network.com. Contact: John Gundling.

PART FIVE
THE IMPORTANCE OF CLOSED LOOP RECYCLING

The most common question about recycling is, "What happens to all this stuff?"

With construction and demolition materials, the question is particularly common, and the answer is often far from clear. When you recycle at home, you can generally envision what happens to the recovered materials: paper gets made into new paper; tin and aluminum cans get melted down to make new steel and aluminum; plastic is melted and extruded into new plastic products.

The same is true of some materials from C&D. Cardboard is paper, and gets recycled into new paper. Wood pallets and dimensional trim get ground up for mulch or boiler fuel.

But concrete with rebar? Asphalt? Shingles? Wallboard? Carpet? Suspended ceilings? These materials are found on almost every job site, and they're generated by the ton or the thousands of square feet. But it's by no means obvious how they can be recycled, much less how they can come back to the job site, or anywhere else for that matter, as a new product.

But it's critically important that they do come back, because recycling amounts to nothing unless there's a reliable outlet for the recycled material: a recycling process, a recycled product, and ultimately, most importantly, a market for that recycled product.

Here the architectural and contracting community can play an important role. Because just as this industry is one of the largest waste generators in the country, it's also one of the largest consumers of raw materials and manufactured products. If the construction industry demands and uses products with recycled content – particularly products with content that comes direct from other job sites – then conditions will be right for C&D recycling to continue to take hold, grow, and become successful. Additionally, if demand for recycled products increases, so will demand for the raw materials recycled on the job site. That will drive recycling costs to the architect and contracting community even lower, and enhance the already strong economic benefits to be gained from recycling.

Practically, using recycled-content products also contributes to LEED certification. Up to two LEED points are available for using recycled-content products (at levels of 25% and 50%), and an additional innovation point may be awarded for a special initiative such as keeping recycled concrete on the job as aggregate in fill or pavement.

The following examples outline the recycling process and describe recycled content products for a number of very common and highly visible C&D wastes. They follow the material from the job site through the recycling process and back into the economy – sometimes back into new construction products, sometimes back into something very different. In all cases, these examples point to ways that the architect and contracting community can contribute to recycling's success by purchasing and using products with recycled content – the most critical part of "closing the loop."

Ceiling Recycling – A Closed Loop Process

Traditionally, as part of demolition or renovation, suspended ceiling panels have been removed from a space, thrown into a dumpster and taken to a landfill for disposal.

Today, rather than dumping discarded ceiling tiles in landfills, a more environmental approach is available. Ceilings can now be efficiently reclaimed and reused through a ceiling recycling program introduced by Armstrong World Industries. Since 1999, Armstrong has recycled more than 20 million square feet of used ceiling tiles into new ceilings.

Ceiling Tiles – Up To 79 Percent Recycled Content

All of Armstrong's ceilings contain recycled content, many up to 79%, effectively reusing both post-consumer and post-industrial waste. Materials used in ceiling tiles include cornstarch, newsprint, mineral wool, recycled paper and perlite. In 2003-04, Armstrong used more than 4 million pounds of recycled materials in the production of new ceilings. With this recycled content, besides being recyclable at the end of their life, ceiling tiles are a solution for sustainable building design and achieving LEED credits during construction (Material Credit #4 for recycled content, and throughout most of New England, Material Credit #5, Local/Regional Materials). Higher levels of recycled content are also available through a Specials Process.

The Armstrong Recycling Program

Most commercial ceilings are 100% recyclable through Armstrong's Ceiling Recycling Program. An owner or contractor who uses the Ceiling Recycling Program reaps the substantial benefits of diverting these materials from landfill, reducing the cost of waste management on the job site, and contributing toward the 1-3 LEED points available for job site recycling.

The Armstrong Ceiling Recycling Program involves four steps. First, provisions for ceiling recycling should be included in the project specifications and/or the construction waste management plan.

Second, building owners need to verify with Armstrong that their old ceiling tiles can be recycled. Most types of pulpable mineral fiber tiles can be recycled. They do not need to be Armstrong products, but materials like asbestos and foil or vinyl backing prevent recycling (see www.armstrong.com/common/c2002/content/files/14832.pdf for specifications).

Third, following verification, the owner or contractor has a number of options to consolidate the tiles for transportation back to Armstrong. The owner/contractor should contact Armstrong to discuss the specifics of the job and determine which option will work best. One option is to stack and stretch wrap the tiles on pallets (Armstrong can spot a trailer at the job site to facilitate loading, and may also be able to provide assistance with labor to stack and shrink-wrap the tiles).

Alternatively, Armstrong can order in an open-top trailer that can be bulk loaded with loose tiles.

And recognizing that many demolition and renovation jobs don't generate a full trailer load of tiles, Armstrong has also partnered with companies that will consolidate smaller loads into full truckloads before shipment to an Armstrong facility. The Institution Recycling Network is an Armstrong consolidator in the New England area.

Transportation is Step Four. Once an owner/contractor or an Armstrong consolidator has accumulated a full trailer load (approximately 30,000 square feet), a call to Armstrong will get this started. Armstrong will pay the freight for shipment to an Armstrong plant, and will recycle the tiles into new ceilings.

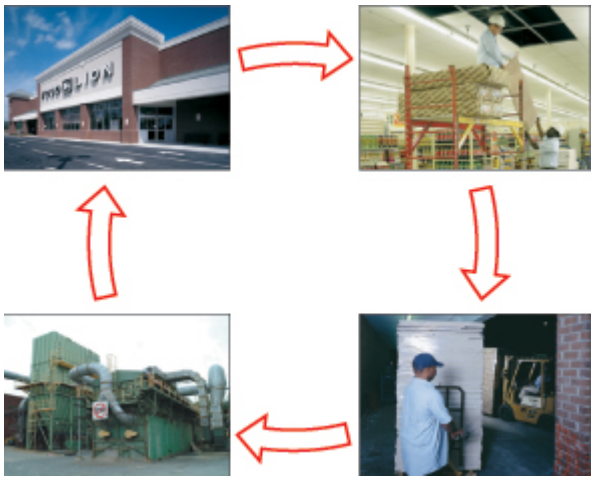
Long-Term Benefits To The Planet

Armstrong's Ceiling Recycling Program offers many benefits:

- *It's an alternative to landfill disposal*. Less waste needs to be put into the earth, and landfill space is conserved.
- *It's economically attractive*. With Armstrong paying the costs to transport and process old ceilings into new, it costs less to recycle than to discard them.
- *The Ceiling Recycling Program conserves natural resources*. Because Armstrong can use up to 79% recycled materials in new ceiling tiles, every pound of ceiling that's recycled conserves a pound of virgin raw materials.
- *Recycling and using recycled content promote sustainability*. As a closed-loop process in the lifecycle of Armstrong ceilings, the Ceiling Recycling Program reduces Armstrong's environmental footprint, and this is an important corporate goal.

Example – Corporate-Wide Recycling Commitment

Food Lion Supermarkets, headquartered in North Carolina, operates some 1,200 stores in eleven states. Food Lion has made a corporate commitment to ceiling recycling as part of its regular program of store maintenance and upgrade. Through the Armstrong Ceiling Recycling Program, Food Lion is recycling more than 2,000,000 square feet (600 tons) of old ceilings per year.



Armstrong World Industries, Inc., a subsidiary of Armstrong Holdings, Inc., is a global leader in the design and manufacture of ceilings, floors and cabinets. Founded in 1860 and based in Lancaster, PA, Armstrong has 50 plants in 15 countries and nearly 16,500 employees worldwide. Additional information on Armstrong's Ceiling Recycling Program, the recycled content of Armstrong products, and other environmental programs can be found at http://www.armstrong.com/commceilingsna/environmental.html.

From Foundation To Roof:
New Life For High-Volume Construction Materials

ABC – asphalt, brick, and concrete – are, by weight, the dominant materials in construction and demolition waste. Any project that can capture and recycle ABC is well on the way toward an excellent recycling rate.

Recycling of ABC is not new. Asphalt pavement can be ground, blended with additional aggregate and new emulsifier, and re-used in new pavement. It can also be used as a crushed stone substitute in fill, embankment construction, and roadway base courses. Brick and concrete (after grinding and removal of rebar) can also be used as aggregate in most of these applications. The fines from ABC recycling are used in many products, from asphalt and fill to manufactured soils.

Other materials in C&D share characteristics with ABC but historically have been difficult to recycle. These include, for example: shingles and other asphalt-based roofing products; porcelain products; window glass, mirrors, and ceramics; contaminated soils; and catchbasin and sandblast grit. But if you search out the right market, all of these products can be recycled as well.

Commercial Paving & Recycling Company is a Scarborough, Maine paving and recycling firm that saw opportunity in these problem materials. In the past decade, CPRC has morphed, in their own words, from "a large paving company doing a small amount of recycling" (mostly asphalt pavement) into "a large recycler doing a small amount of paving." CPRC's product mix, which includes a number of proprietary technologies and products, is testament to the recycling opportunities that can be found even in "oddball" C&D waste streams.

Commercial Paving & Recycling handles almost *any* aggregate-based or aggregate-like material (see Table). The most common aggregates – asphalt, brick, concrete, concrete block – are ground and used in a variety of paving and fill products. Other oddball aggregate-like materials, such as glass, tiles, and porcelain fixtures (toilets, tubs, sinks, urinals, etc.), are used in some of these same products.

Other C&D wastes find other homes. In 2003, CPRC recycled over twenty thousand tons of roofing shingles, which are recycled into asphalt paving mixes, a proprietary asphalt cold patch mix, and several fill, subgrade, and unpaved road surface products. Asphalt membrane roofing is recycled into similar products. Catchbasin and sandblast grit (historically a problem because of contamination with paints and oils) are used in a variety of fill and subgrade aggregate mixes. Many of the fines generated when aggregates are crushed (that is, the dust-sized particles from crushing operations) are incorporated into a proprietary manufactured soil that Commercial Paving markets to establish vegetation in road and other construction projects.

This product is an example of new markets that are developing for C&D wastes. In addition to the manufactured soil, Commercial Paving has also developed a cold patch product, Jack's Patch®, that uses recycled asphalt roofing shingles, Hot De-Icer™, an ice and snow control product (also used as cover for sand and salt piles) that includes a variety of reclaimed aggregates, and "Reclaim", an aggregate product for roadway and parking lot construction that

includes “dirty” materials such as contaminated soil and catchbasin grit, along with other recycled aggregates.

Two final points are critical. First, the cost to recycle these materials, compared to the cost of disposal, is small. For example, CPRC’s 2004 gate rate to recycle loads of brick and concrete (unless it contains large amounts of rebar) is less than $10.00 per ton. The rate to recycle asphalt shingles ranges from $36.00 to $46.00 per ton depending on type of shingle. Recycling costs for other materials are similar. Given the large volumes generated on many projects, savings to recycle rather than dispose of these materials can run to tens of thousands of dollars. And the price difference between recycling and disposal means that recycling can be cost effective even if the project site is 150 or 200 miles away.

Second, closing the loop. The products that are manufactured from recycled aggregates are used, sometimes in very large quantities, on almost every construction job, for grading, paving, fill, or landscaping. So it’s possible to ship a concrete wall out as waste, then bring it back to the site in a new product. There are few better or more meaningful commitments to sustainable building. There’s also a LEED point for incorporating recycled materials in new construction, and a potential innovation point for documenting closed loop recycling on the job. Closed loop recycling makes great public relations. And closed loop recycling is essential to expanding and sustaining the recycling infrastructure; when architects and contractors demand recycled content products, that increases demand for recyclable raw materials, which expands markets and brings down recycling costs.

So look at an old concrete foundation and see a new parking lot or landscape swale. It’s a recycling commitment that’s easy to make, and makes sense from every perspective.

PRODUCTS MANUFACTURED FROM RECYCLED ASPHALT, BRICK, CONCRETE, ROOFING, AND OTHER MATERIALS

Product Manufactured with Recycled C&D Waste Content	**Construction and Demolition Waste Material**						
	Asphalt	Brick, Concrete	Glass, Porcelain, Ceramic	Roofing Shingles	Membrane Roofing	Catch-basin Grit	Processed Contamin-ated Soils
Bituminous Concrete Mixes	√	√		√	√		
“Jack Patch” Cold Patch Mix	√			√			
Crushed Gravel Substitutes		√	√	√		√	
“Reclaim” Base and Fill						√	√
Hot De-Icer	√			√			
“Top Soilution” Manufactured Soil		√					√

Commercial Paving and Recycling, Co., LLC is headquartered in Scarborough, ME. Additional information on the company’s recycling programs and recycled content products is available at www.cpcrs.com.

Carpet: Recycling A Complex Material

According to the Carpet and Rug Institute (CRI), more than 4.9 billion pounds of carpet are discarded into the U.S. waste stream each year. It can take up to 50 years or more for typical broadloom carpet to decompose in a landfill. Clearly there is a great need to find alternative solutions.

In 2002, representatives of the carpet industry joined with the U.S. EPA plus several states and non-government organizations to form the Carpet America Recovery Effort (CARE; see www.carpetrecovery. org), with a goal to recover, reuse and recycle 40% of post consumer carpet over the next 10 years. Interface Flooring Systems is an active participant in this effort, building on efforts undertaken on their own for over ten years.

Technology that will allow new carpet to be made from old carpet is developing rapidly but is still far from being the industry standard. Unlike single-component products such as wood or metal, carpet is made of many raw materials that must be separated to be truly recyclable.

Carpet Recycling Options

Interface has a program called ReEntry® that takes back carpet from a job site, regardless of the manufacturer. Interface's commitment is to make recycling available in any project where Interface carpet is being installed. Since 1994, Interface has diverted more than 50 million pounds of materials from landfill via the ReEntry® program. Depending on the product type and condition, a number of options are available:

- If it's in good shape, the carpet can be **repurposed** – that is, donated to a group such as the Boston Building Materials Resource Center (www.bostonbmrc.org), or another organization that can reuse the material. If it's possible, this is the best and highest recycling option.
- Some component parts can be **recycled**, for example, vinyl carpet backing into vinyl backing;
- Some can be **upcycled**, producing a higher value product. Polyethylene terephthalate (PET) fiber that is melted and re-extruded to produce fabric is an example.
- Some components can be **downcycled** into lower value products, such as auto parts, carpet padding, or plastic lumber. Waste-to-energy falls into this category.

Recycling and the Product Lifecycle

But disposal is only one part of the "lifecycle" for carpet or any building product. It's important that the questions you ask about building materials and their environmental impacts take into account the entire lifecycle of the product, from manufacture to ultimate disposal, because it's not just recycling, but environmental and energy impacts from raw material extraction right through the end of product life that need to be optimized. Relevant questions include:

- What raw materials are used? Is there any recycled content? (Many Interface products are manufactured using recycled raw materials; this information is available for each Interface product line – see web links below.)

- How is the product manufactured, and what are the environmental impacts during manufacture?
- How is the product installed, and what waste is generated in that process?
- What recycling options are available to keep the product from the landfill when it is discarded?
- What will happen to the product when it is recycled; that is, what new products can be manufactured from the product?

One way to determine the sustainability of products is to look for third-party certification. Many organizations provide certifications so it's important to study both the group issuing the "seal of approval" and the criteria used to certify a product. Look for stringent criteria that address a wide array of issues.

Carpet and the Interface Commitment

Part of Interface's core business philosophy is concern about products through their entire lifecycle, from manufacture through installation and use to ultimate disposal.

For example, during the design phase, consider how a space is laid out and what materials will be used there. Consider these choices with a long-term perspective. If carpet is being used in a high-traffic area, consider using a modular carpet that allows for smaller sections to be replaced when worn or damaged instead of re-carpeting the entire space. Furthermore, modular carpet typically creates less waste when installed as compared to rolled carpet.

When a space is reconfigured to adapt to company growth or changes, or if the company moves to another location, think about what components could also move. Furnishings, equipment and even modular carpet can often be relocated right along with the company.

And when it's time to make a recycling decision, both environmental and economic considerations should be evaluated. For example, if energy use, transportation, and other costs to recycle a product are greater than the value of the original product or the recycled product, alternatives (including waste-to-energy) should be considered.

Ultimately, perhaps the easiest way to think about building materials – carpet or anything else – is to consider that you're leasing or borrowing them, not buying them. These products had a life as raw materials before being manufactured and purchased. Make sure that these lifecycle processes – manufacturing, distribution, and installation – are as environmentally benign as possible. Through recycling or disposal, products also have a life beyond your current use. Educate yourself about recycling options and technologies to be sure that that next life is restorative, not destructive.

For more information on Interface products go to www.interfaceflooring.com. For information on Interface's mission toward sustainability go to www.interfacesustainability.com, or contact David Whitley, Interface's Director of Sustainable Practices (david.whitley@us.interfaceinc.com). For more information on ReEntry® contact Susan Lewis at 1-888-REENTRE or susan.lewis@us.interfaceinc.com.

Gypsum Wallboard: Recycling On Many Fronts

Total U.S. shipments of gypsum wallboard were approximately 32 billion square feet in 2003, nearly 735,000 acres of wallboard. Gypsum wallboard is used in almost every construction and renovation project in the United States. It's one of the most ubiquitous and most visible construction materials in the country. Wallboard is also a great example of how environmental and economic considerations have worked together to shape a recycling success story – a success story that has many facets, from raw materials, to recycling, to the use of recycled products.

Recycling – Discarded Wallboard into New

There are two ways that wallboard scrap can be recycled.

Some wallboard plants recycle their own process waste, and some plants have been equipped to handle and recycle clean wallboard scrap from new construction sites as well. The scrap, including the paper backing, is ground, mixed with virgin gypsum, and sent through the normal manufacturing process, emerging as new wallboard. The wallboard with recycled content is indistinguishable in performance from wallboard manufactured from only virgin gypsum.

In New England, one factor limiting this option is transportation. The cost to recycle wallboard once it reaches the plant is generally less than the cost of disposal, however, transportation from distant building sites can make the total cost of recycling higher.

Where wallboard-to-wallboard recycling is not yet available, wallboard can also be used as a soil amendment. Ground and worked into the land, it helps improve workability and water penetration, buffers the corrosive effect of alkalinity, and has value as a soil nutrient. In residential or commercial construction, wallboard can be ground and applied on site during landscaping.

At present, in New England, only clean wallboard scrap from new installations can be recycled. Wallboard from demolition and renovation is typically commingled with materials such as paint, wallpaper, nails, adhesives, joint compounds, tape and other contaminants. With present technologies it can't be recycled, because of the cost of separating these materials, and concerns associated with contaminants such as lead-base paint. Where recycling is not possible, wallboard can be disposed of safely in a properly managed landfill.

Recycled Paper

The North American gypsum industry has used recycled paper to manufacture gypsum board face and back paper for nearly half a century. Today, essentially 100 percent of gypsum board paper used in the U.S. is manufactured from recycled fiber. With over 32 billion square feet of gypsum board shipped annually in the United States, the gypsum industry is utilizing nearly 65 billion square feet, over 1.4 million acres, of recycled paper each year.

Synthetic Gypsum – Raw Material from Waste

The predominant raw material in wallboard is gypsum, or calcium sulfate dihydrate. This mineral is found in sedimentary rock formations, and the majority of gypsum used in wallboard is mined from these sources. But calcium sulfate is also the byproduct when coal-fired power plants "scrub" their smokestack emissions to remove sulfur dioxide (a serious air pollutant). This scrubber byproduct is categorized as one of the highest volume industrial wastes in the U.S. Historically, it has been landfilled.

At a number of power plants across the country, the wallboard industry has turned this problem situation into a recycling success, using scrubber byproduct as the raw material to manufacture gypsum wallboard. Approximately 20 percent of the wallboard manufactured in the U.S. now comes from factories that use the synthetic byproduct (known as synthetic gypsum or desulfogypsum, DSG) as their raw material. This wallboard is indistinguishable in performance in all respects from wallboard that is manufactured from mined gypsum. Not every manufacturing plant can be co-located to collect synthetic byproduct; however, wallboard manufactured from synthetic gypsum is available for purchase throughout most of the United States. The use of synthetic gypsum as a substitute for the natural mineral has grown rapidly since 1990, and continues to do so.

Some of these co-located plants gain additional economies and environmental benefits by "thermal hosting." Waste heat is another byproduct of power generation that is typically lost to cooling water or allowed to dissipate to the atmosphere. But at a number of locations, this heat is transferred as hot water or steam to a wallboard plant, where it provides the process heat needed to manufacture new wallboard. The wallboard plant reduces energy consumption and emissions; the power plant reduces thermal waste and the expense of running its cooling system. Again, it's a winning situation, for the two facilities, for the economy, and for the environment.

The Gypsum Association represents U.S. and Canadian gypsum board manufacturers with nearly 100 plants in 30 states and 8 provinces, underground mines and quarries, paper plants, and joint treatment compound plants. The U.S. and Canadian industries employ over 30,000 people in some 100 communities throughout the two countries; additional jobs are provided indirectly in the transportation, distribution, and installation of gypsum board and related products

Recycling Mixed Debris:
Getting the Most from Mixed Large Quantity Wastes

Mixed debris is the common commodity on all construction sites. No matter how many materials are source-separated, there will always be a mixed debris container as well. On some sites, mixed debris may be the recycling option for most of the waste. For example, in an urban multi-story building with room for one chute and one container on the ground, there may be no option but to fill the container with mixed debris. Schedule, demolition methods, job size, or site limitations are all factors that can push much or most of the waste stream into mixed debris.

Mixed debris recycling is also subject to a lot of confusion. What does it mean? How are the wastes processed? Where do they go? How do you interpret a mixed debris recycling rate? Among firms that offer mixed debris "recycling," there are some that grapple out metals and some aggregate, maybe 30-40% of the load, and landfill the balance. There are others that simply run entire container loads through a grinder to reduce volume, then spread the output on a landfill as "Alternate Daily Cover" (ADC); the volume has been reduced, but the essential goal of recycling – returning materials to productive use – is not accomplished. When you choose to recycle mixed debris, it's important to understand what mixed debris "recycling" can mean, and to be comfortable with the processor and the option you select.

ERRCO C&D Recycling in Epping, NH is one of the established mixed debris recyclers in New England, with one of the more comprehensive (and battle tested) processes. They provide a good benchmark to measure the effectiveness of mixed C&D recycling, and to understand what happens to the products that are generated when mixed debris is processed.

A Ten-Step Recycling Process

ERRCO's recycling process involves ten steps. Although the process is labor- and capital-intensive (ERRCO runs a crew of 20 workers per shift, two shifts a day), the result is an output that returns about 85% of inbound materials to productive use, with about 9% to Alternate Daily Cover and only 4% landfilled as waste.

1. Inspection: Perhaps the most important step in the process, inspection identifies and removes hazardous materials like asbestos siding or lead flashing that can corrupt an entire load or an entire day's production. Contaminated loads are returned to the generator or landfilled at the generator's expense.

2. Pre-Sort: A grapple picks out non-recyclable items and items that cannot go through ERRCO's recycling process. These include, for example, pieces of furniture, carpet (if has been placed in a mixed debris container, recycling is impossible), tires, and "household" trash. Tires, large pieces of metal, and some other items are segregated and recycled; the balance is landfilled.

3. Initial Screen: A 2"-minus screen removes fines that are diverted to ADC. Ferrous metals are removed from this stream by magnet.

4. Manual Pick Line: Manual picking removes the majority of nonferrous metals, cardboard, and some aggregate, all of which are recycled. Contaminants like plastic sheeting and plastic containers are also pulled out. ERRCO is working with a manufacturer of plastic "lumber" to market the mixed plastic fraction, but it is currently being landfilled.

5. Grind: The output from the pick line, primarily wood and aggregate, is ground to 8"-minus. Another magnet pulls additional ferrous metals.

6. Trommel: A 3/8-inch screen removes fines, which are marketed as ADC.

7. Second Pick Line: A second manual sort removes additional contaminants (plastics, rubber, paper), which are landfilled, and nonferrous metals, which are recycled.

8. Wash Tank: The wash tank is a water-filled tub in which materials either float or sink. The wastes that enter the wash tank are primarily wood (floats) and aggregate (sinks), which are separated here.

9. Third Pick Line (materials from wash tank): A final hand sort of materials that sink in the wash tank removes remaining nonferrous metals.

10. Final Grind. Materials that float through wash tank (nearly 100% wood) are ground once again, to 2"-3"-minus, and hit with a final magnet to pull plates, nails, and other fasteners.

The Products of Mixed Debris Recycling

At the end of the line, ERRCO markets six different products (see Figure). In a typical day's run, wood chips make up about 60% of ERRCO's output; these are marketed as boiler fuel to one of several biomass-to-energy combustors in New England. By weight, the next largest fraction is clean aggregate (10%), marketed for reuse in asphalt and other aggregate mixes. Alternate Daily Cover, mixed aggregate (from the wash tank), and metals each account for 8-9% of ERRCO's output. ADC is marketed to regional landfills, as is the mixed aggregate fraction (which is used as roadbase material). Ferrous and nonferrous metals are sold in bulk. Only about 4% of a typical day's run is landfilled as waste.

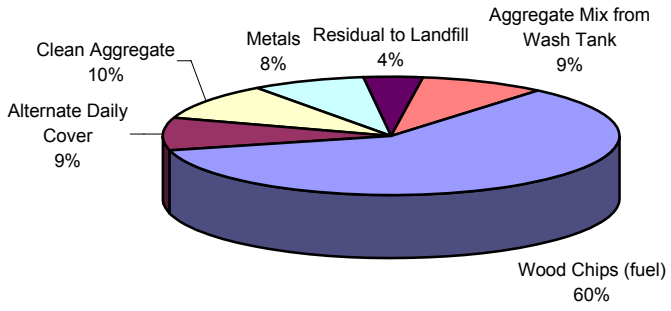
With the flexibility built into its process, ERRCO has the capability to handle partially separated loads of wastes in different ways, with attendant differences in processing costs. A fundamental distinction exists between mixed demolition debris and mixed construction debris. Demolition wastes tend to be more homogeneous and are less likely to be mixed with materials like cardboard, plastics, and nonrecyclable household trash. As a result, ERRCO's processing fee for demolition waste is about $15 per ton less than its fee for construction wastes. ERRCO also charges lower gate rates for loads that consist largely of wood, ABC ("Asphalt, Brick, Concrete"), and metal.

The Costs and Impacts of Mixed Debris Recycling

Financially, ERRCO reinforces the case that C&D recycling can be much less expensive than disposal. ERRCO's 2005 recycling charge for mixed demolition debris is about $55 per ton; its charge for mixed construction debris is $69 to about $72 per ton. The charge for source-separated loads consisting primarily of wood or ABC are even lower. Compared to regional landfill costs that can reach nearly $100 per ton, the economic argument to recycle rather than dispose of mixed C&D is compelling, even if recycling sometimes involves longer transportation distances.

Equally important, the quantities of wastes that can flow through a facility like ERRCO are very large, with equally large impacts on the consumption of regional landfill capacity. ERRCO can process up to 70 tons of mixed debris per hour, or about 1,000 tons per day, or nearly 250,000 tons per year. Landfilled C&D consumes 3-4 cubic yards per ton, so a facility of this size has the capability to conserve 700,000 to 1,000,000 cubic yards of landfill capacity every year – about the volume needed to handle household trash from 250,000 people. The environmental impacts of diverting C&D wastes from disposal are indeed significant.

Products of ERRCO Mixed Demolition Debris Recycling



ERRCO C&D Recycling is located in Epping, NH. Additional information about ERRCO's services, material specifications, recycling process, and products can be found at www.errco.com.

Appendix A
RECYCLABLE CONSTRUCTION AND DEMOLITION MATERIALS AND MARKETS

Material	Description and Sources	Markets	Limitations on Recycling
Brick	Largely from demolition and renovation. Limited waste from new construction.	High-value re-use markets for some brick. More often placed in mixed aggregate markets, with concrete and block. Used in aggregate production.	Few limitations.
Concrete, Formed	Largely from demolition and renovation. Limited waste from new construction.	Mixed aggregate markets with brick and block. Used in aggregate production.	Concrete w/ rebar typically must be separated from brick, block, and concrete w/out rebar. Lead paint an issue where present.
Concrete Block	Largely from demolition and renovation. Limited waste from new construction.	Mixed aggregate markets with brick and concrete.	Few limitations.
Asphalt Pavement	Almost exclusively from parking areas. Limited waste from new construction.	Typically recycled separately from other materials. Used in production of new asphalt.	Few limitations.
Metals, Ferrous	Structural and framing steel from demolition. Framing scrap from new construction and renovation. Typically very little structural steel from new construction or renovation.	Scrap markets; used in production of new steel.	Few limitations.
Metals, Non-Ferrous	Aluminum, copper, brass and alloys from electric, plumbing, and HVAC. Often significant scrap in new construction.	Scrap markets. Highest value if separated by metal at point of generation. Can be mixed and marketed with ferrous metals.	Few limitations.
Wood, Dimensional	Two-by ends from new construction and renovation. Whole boards from renovation and demolition. Pre-fabbed walls and trusses greatly reduce waste.	Reuse markets available in most areas for whole boards. Scrap goes primarily to mulch and boiler fuel.	Generally few limitations. Some markets refuse nails and screws.
Wood, Flooring, Trim	Largest quantities from demolition and renovation. Ends and scrap from new construction and renovation.	Can be high reuse value in hardwood and softwood flooring and some trim & molding. Painted/treated wood, scrap and damaged wood goes primarily to boiler fuel.	Limited markets for painted or treated wood. All painted/treated wood should be tested for lead.

Material	Description and Sources	Markets	Limitations on Recycling
Wood, Engineered	Plywood, OSB, glu-lam beams, etc. Significant quantities from new construction and renovation as well as demolition. Pre-fabbed walls and trusses greatly reduce waste quantities.	Some re-use value through deconstruction. Most is recycled as boiler fuel.	Generally few limitations.
Gypsum Wallboard	Clean scrap from renovation and new construction. Currently no markets for demolition wallboard.	GP Gypsum and U.S. Gypsum offer recycling capabilities in N.E.. A few markets grind as soil amendment.	Clean scrap from new installation only, without tape, nails, screws, corner bead.
Ceiling Tiles	Largely from demolition and renovation. Generally limited waste from new construction.	Armstrong Ceiling Systems accepts and recycles most ceiling tiles, when consolidated to truckload volumes (30,000 sq ft).	No mold; no asbestos or other hazmat; no vinyl, fabric, or foil faced tiles; no visible wood pulp or cardboard-like face. Armstrong takes tiles for testing prior to recycling.
Porcelain Fixtures	Demolition and renovation only. Usually none from new construction.	Ground and used as aggregate or decorative chip.	Generally require removal of seats and plastic/metal fixtures.
Roofing, Asphalt Shingles	Large quantities from demolition and renovation. But also frequently significant scrap from new construction.	Asphalt and other paving materials	No asbestos or other hazmat. Metal (nails, flashing, etc.) typically acceptable.
Roofing, Membrane	Large quantities from demolition and renovation. But also frequently significant scrap from new construction.	Asphalt and other paving materials.	No asbestos or other hazmat. Metal (flashing, dripedge, etc.) typically acceptable.
Roofing, Metal	Large quantities from demolition and renovation. But also frequently significant scrap from new construction.	Scrap markets.	Few limitations.
Roofing, Slate	Large quantities from demolition and renovation. But also frequently significant scrap from new construction.	Often reusable. Damaged roofing ground and used as aggregate.	Few limitations.
Carpet	Large quantities from replacement, demolition, renovation. Significant scrap from new installation.	Several manufacturers accept their own or other carpet for recycling. Other markets available but limited. Carpet is taken apart into multiple materials which are then recycled separately.	Carpet must be dry and mold free. Cost is typically very high. Recycling most often feasible with replacement installation.
Mixed Debris	Large quantities from demolition and renovation. Small to large quantities from new construction, depending on feasibility of source separation.	Sorted mechanically and/or by hand into constituents, typically wood, metal, aggregate, and residual.	Hazmats (lead, asbestos, treated wood) may preclude recycling or increase recycling expense. Recycling rates typically less than source-separated, and costs are typically higher.

Appendix B
SOURCES OF INFORMATION ON HAULERS AND MARKETS

Connecticut

Haulers: Connecticut does not maintain information on waste haulers. The state suggests searching on-line or off-line yellow page listings. Haulers are required to register in the municipalities in which they operate, so many municipalities may have listings of local haulers.

Markets: A printed list of permitted C&D processing facilities is available from the CT Dept of Environmental Protection at 860-424-3365. A listing of aggregate recycling facilities is available at www.dep.state.ct.us/wst/recycle/construct. For information on other markets (metals, wood, fibers, etc.) the state suggests searching on-line or off-line yellow page listings.

Maine

Haulers: The state does not maintain a central source of information on waste haulers. The state suggests contacting municipal recycling officials in the community in which a project is located (directory at www.state.me.us/spo/recycle/docs/RecyclingPrograms2003.pdf), or searching yellow page listings on-line or off-line.

Markets: The Maine State Planning Office offers a searchable ***Waste Management Services Directory***, at www.maine.gov/spo/recycle/bizrecycling/index.php.

Massachusetts

Haulers: A listing of haulers that serve residential customers is available at www.mass.gov/dep/recycle/files/haulers.pdf. Most (but not all) of these haulers also provide service to commercial and C&D customers. Information can be obtained by contacting individual haulers.

Markets: The ***Recycling Services Directory*** maintained by Massachusetts WasteCap, www.wastecap.org/wastecap/rsd2003.

New Hampshire

Haulers: Haulers who have identified themselves to the NH. Dept of Environmental Services are listed at www.des.state.nh.us/SWTAS/haulers.htm.

Markets: The NH Dept of Environmental Services, Solid Waste Technical Assistance Section, has market information at www.des.state.nh.us/SWTAS/marketsforMaterials.htm.

Rhode Island

Haulers: The state does not maintain information on haulers, and suggest common sources such as the Yellow Pages and internet as the source of such information.

Markets: A printed list of the licensed C&D processing facilities in Rhode Island is available from the RI Dept of Environmental Management at 401-222-2797.

Vermont

Haulers: A listing of Vermont haulers is posted at www.anr.state.vt.us/dec/wastediv/rcra/pubs/AllTrans.pdf.

Markets: The VT Agency of Natural Resources maintains an extensive C&D website, which includes some market information, at www.anr.state.vt.us/dec/wastediv/recycling/c&d.htm.

Appendix C
RFP/CONTRACT LANGUAGE SPECIFYING C&D RECYCLING

The following sample specifications can be obtained in electronic word processing format from the Institution Recycling Network (603-229-1962 or www.wastemiser.com). Additional examples may be found and downloaded from web sites listed at the end of this Appendix.

Example 1

This is a comprehensive and detailed specification that lays out very specific procedures for preparation of the Waste Management Plan, material tracking, recordkeeping, and reporting.

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 Related Sections (edit as appropriate for consistency)

A. Section 01031 - Waste Management / Recycling Alternates
B. Section 01060 - Regulatory Requirements
C. Section 01094 - Definitions
D. Section 01300 - Submittals
E. Section 01600 - Materials and Equipment

1.2 Description of Work

A. This section describes the requirements for the Contractor and all subcontractors to minimize construction waste and debris and to reuse, salvage, and recycle to the greatest extent feasible.

B. This section includes a statement of [OWNER]'s Waste Management Goals, requirements for the development of a draft and final Waste Management Plan, a reference to resources to assist in recycling, and steps for Management Plan Implementation.

C. This section specifies certain wastes that are required to be recycled.

D. This section specifies obligations for Reporting to the [OWNER] weights of materials recycled and materials not recycled or reused throughout the project.

1.3 Intent and Waste Management Goals

A. [OWNER]'s waste management goals include increased recycling and conservation of materials. Construction and Demolition Wastes have been identified as a particular target for reuse and recycling, for several reasons:

- C&D debris typically represents a large volume of material;
- Many of the waste streams generated during building demolition and construction projects are highly recyclable at reasonable prices;
- Massachusetts has banned landfill disposal of some C&D debris, and expects to ban other C&D debris in coming years.

B. [OWNER] has determined that reducing, to the maximum extent practicable, the amount of waste disposed of in this project is a high priority. The Contractor and subcontractors shall take steps to generate the least amount of waste possible by minimizing waste due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Of the inevitable waste that is generated, as many of the waste materials as economically feasible shall be segregated for reuse, salvage, or recycling, or recycled as mixed debris. In no case shall material be disposed of in a landfill or incinerator where an approved and less costly recycling or reuse alternative exists. Waste disposal in landfills and incinerators shall be minimized and shall be considered the alternative of last resort.

D. With regard to these goals the Contractor shall develop, for the Owner's review and approval, a Waste Management Plan for this Project as described in Section 1.4.

1.4 Draft Waste Management Plan

A. Within 14 calendar days after receipt of Notice of Award of Bid, and prior to any waste removal, the Contractor shall submit a Draft Waste Management Plan to [OWNER OR PROJECT MANAGER OR ARCHITECT, AS APPROPRIATE]. The Draft Waste Management Plan shall contain, as a minimum:

1. A written analysis of the project wastes expected to be generated, by type and approximate quantity.

2. Disposal options: The name of all landfill(s) and/or incinerator(s) proposed for trash disposal, the respective tipping fee(s) for each of these disposal options including transportation costs, and the projected cost of disposing of all Project waste in the landfill(s).

3. Alternatives to Landfill Disposal/Incineration: A list of each material proposed to be salvaged, reused, or recycled during the course of the Project, the proposed end use or market for each material, the respective tipping fees for each end use or market (including transportation costs), and the estimated net cost savings or cost increase resulting from recycling each material (versus landfilling or other disposal), taking into account revenue from the sale of recycled or salvaged materials and tipping fees saved due to diversion of materials.

4. The Draft Waste Management Plan shall include, at a minimum, the materials included in Section 1.5 that are required to be reused or recycled.

B. Following the submittal of the Draft Waste Management Plan, [OWNER] and Architect will review the plan and consider the proposed recycling and waste disposal alternatives. The Owner and/or Architect may suggest alternatives to the proposed disposal options in order to increase recycling, reduce costs, or both.

1.5 Materials for Which Recycling Is Required

A. [OWNER] requires that, as a minimum, the following materials must be considered for recycling, salvage, or reuse during this project:

[ADD OR ELIMINATE MATERIALS AS APPROPRIATE TO PROJECT]
Asphalt
Concrete, concrete block, concrete masonry units (CMU), slump stone (decorative concrete block), and rocks
Asphalt Concrete
Brick

Paper, including bond, newsprint, cardboard, mixed paper, packing materials, and packaging
Cement Fiber Products, including shingles, panels, siding
Paint
Rigid Foam
Glass
Plastics
Carpet and Pad
Beverage Containers
Insulation
Gypsum Wallboard
Porcelain Plumbing Fixtures
Fluorescent Light Tubes, per [REGULATORY AGENCY] regulations
Green materials (i.e. tree trimmings and land clearing debris).
Metals including, but not limited to, stud trim, ductwork, piping, reinforcing steel (rebar), roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze. (ferrous and non-ferrous).
Soils
Wood, including clean dimensional wood, pallet wood, plywood, oriented strand board (OSB), particle board

B. [MODIFY FOR OTHER STATE AS APPROPRIATE] The Contractor should be aware that the Commonwealth of Massachusetts has banned the following waste streams from incineration or landfill disposal. These items may not be included in waste destined for incineration or landfills:

1. Lead-acid batteries
2. Leaves and Yard Waste
3. Whole Tires
4. White Goods (Appliances)
5. Cathode Ray Tubes (CRTs) including computer monitors
6. Metal, Plastic and Glass Containers
7. Recyclable Paper

1.6 Resources for Development of Waste Management Plan

The following sources may be useful in developing the Draft Waste Management Plan:

1. *Recycling Haulers and Markets*. An extensive list of Massachusetts haulers and markets for recyclable materials is available on-line at the following URL: www.wastecap.org/wastecap/rsd2003. This list is provided for information only and may not comprehensive; other haulers and markets may also be available. [MODIFY FOR OTHER STATE]

1.7 Final Waste Management Plan

A. Once [OWNER] has considered the draft Waste Management Plan and made appropriate suggested modifications, the Contractor shall submit, within 14 Calendar days of receiving such suggested modifications, a Final Waste Management Plan, incorporating [OWNER]'s input. The Final Waste Management Plan shall contain the following:

1. Analysis of the proposed jobsite wastes to be generated, including types and approximate quantities.

2. Disposal options: The name of all landfill(s) and/or incinerator(s) proposed for trash disposal, the respective tipping fee(s) for each of these disposal options including transportation costs, and the projected cost of disposing of all Project waste in the landfill(s)

3. Alternatives to Landfilling: A list of the waste materials from the Project that will be separated for reuse, salvage, or recycling.

4. Markets: A list of the market(s) or other on-site or off-site end use(s) that will be used for each material that will be separated for reuse, salvage, or recycling.

5. Materials Handling Procedures: A description of the means to be employed in separating and recycling the materials identified in item (3) above consistent with requirements for acceptance by designated facilities, including the means by which such materials will be protected from contamination.

6. Transportation: A description of the means of transportation of the recyclable materials (whether materials will be site-separated and hauled to designated markets, or whether mixed materials will be collected by a hauler and removed from the site and later separated for recycling).

7. Cost of Reuse, Salvage, or Recycling. An estimate of the cost, including separation, transportation, and marketing, to reuse, salvage, or recycle the materials identified in item (3) above.

8. Meetings: A description of the regular meetings to be held to address waste management. Refer to Section [XXX] - Project Meetings

1.8 Waste Management Plan Implementation

A. Manager: The Contractor shall designate a specific party (or parties) responsible for instructing workers in recycling and overseeing and documenting results of the Waste Management Plan for the Project.

B. Distribution: The Contractor shall distribute copies of the Waste Management Plan to the Job Site Foreman, each Subcontractor, the Owner, and the Architect.

C. Instruction: The Contractor or his designated waste manager shall provide on-site instruction regarding appropriate separation, handling, and recycling, salvage, reuse, and/or return methods to be used by all involved parties at the appropriate stages of the Project.

D. Separation facilities: As appropriate during each stage of the Project, the Contractor shall lay out and label a specific area(s) to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.

E. Hazardous wastes: Hazardous wastes shall be separated and disposed of according to Section [XXX].

1.9 Reporting Required at Time of Invoicing

A. Application for Progress Payments: The Contractor shall submit with each Application for Progress Payment a Summary of Waste generated by the Project. Failure to submit this information shall render the Application for Payment incomplete and shall delay Progress Payment. The Summary shall be submitted on a form acceptable to the Owner and shall contain the following information:

1. The amount (in tons) of material landfilled from the Project, the identity of the landfill, the total amount of tipping fees paid, transportation costs (if separate) and the total disposal cost. Include manifests, weight tickets, receipt, and invoices.

2. For each material recycled, reused, or salvaged from the Project, the amount (in tons or cubic yards), the date removed from the jobsite, the receiving party, the transportation cost, the amount of any money paid or received for the recycled or salvaged material, and the net total cost or savings of salvage or recycling each material. Attach manifests, weight tickets, receipts, and invoices.

Example 2

This is a simpler specification that includes requirements for recycling, recordkeeping, and reporting, but is less prescriptive in providing detailed instructions and requirements on the contractor.

Waste Disposal and Recycling

[OWNER] has implemented strict recycling and waste management policies for all waste materials removed from its campus as a result of construction and demolition activity. These include:

[ADD OR ELIMINATE MATERIALS AS APPROPRIATE TO PROJECT]
Asphalt
Concrete, concrete block, concrete masonry units (CMU), slump stone (decorative concrete block), and rocks
Asphalt Concrete
Brick
Paper, including bond, newsprint, cardboard, mixed paper, packing materials, and packaging
Cement Fiber Products, including shingles, panels, siding
Paint
Rigid Foam
Glass
Plastics
Carpet and Pad
Beverage Containers
Insulation
Gypsum Wallboard
Porcelain Plumbing Fixtures
Fluorescent Light Tubes, per [REGULATORY AGENCY] regulations
Green materials (i.e. tree trimmings and land clearing debris).
Metals including, but not limited to, stud trim, ductwork, piping, reinforcing steel (rebar), roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze. (ferrous and non-ferrous).
Soils
Wood, including clean dimensional wood, pallet wood, plywood, oriented strand board (OSB), particle board

The successful bidder will be required to account for all waste materials removed from the Project, and to recycle, salvage, or reuse, to the maximum practicable extent, all of the materials listed above. If the successful bidder believes that recycling, salvage, or reuse of any of these materials is impracticable, the bidder must so inform [OWNER] before initiation of the Project, and secure [OWNER]'s written authorization for an alternative means of disposal.

The successful bidder will be required to develop and maintain a plan which documents procedures to recycle, salvage, or reuse the materials listed above, including separation and recycling procedures and markets for each material recovered. This plan must also address training and communications, recordkeeping, and reporting requirements to assure that all waste materials are accounted for. As the project proceeds, this plan is to be updated with the quantities of each waste that are actually reused, salvaged, recycled, or disposed of, and the markets to which these materials are directed, so that it provides documentation in a single source of waste management performance on the Project.

[OWNER] retains the right to inspect, and subsequently approve or disapprove any and all recycling end markets, reuse or salvage outlets, and/or waste disposal facilities that are involved in the receipt of

recyclables and/or waste materials generated from the Project. Disapproval of such a market or outlet may be based on past or current violations of federal or state environmental, health, or safety laws, improper disposal activities, risk or liability exposure, or any other reason deemed sufficient by [OWNER].

The successful bidder shall maintain records for each type of material removed from the job site (including materials that are not recycled), provide the name(s) of specific end destinations for all materials removed (whether recycled or disposed of), and provide weights and measures of all materials removed. Every load of waste material must be weighed and these scale weights must be reported to [OWNER] on a monthly basis, detailing material types and net weights. [OWNER] retains the right to certify weights of sample loads of materials leaving the project site, and compare these to the weights submitted by the successful bidder. [OWNER] retains the right to request copies of original scale tickets for any and all materials removed from the Project up to two (2) years following project completion.

Upon request, [OWNER] will provide assistance to the successful bidder in identifying markets for recyclable materials. If any bidder is unfamiliar with recycling procedures and/or markets for the materials listed above, information is available from the following sources:

INSERT CONTACT INFORMATION OR WEB LINKS

ADDITIONAL RESOURCES

The following web sites provide additional examples of Request for Proposal and/or specification language addressing job site recycling:

www.tjcog.dst.nc.us/cdwaste.htm#wastespec
Source/author: Triangle J Council of Governments (NC)

www.ciwmb.ca.gov/ConDemo/Specs/
Source/author: California Integrated Waste Management Board

www.wbdg.org/design/index.php?cn=4.3.4&cx=0
Source/Author: Whole Building Design Guide

www.epa.gov/rtp/new-bldg/environmental/s_01690.htm
Source/author: U.S. Environmental Protection Agency

www.stopwaste.org/fsbuild.html
Source/author: Alameda County Waste Management Authority

APPENDIX D

SAMPLE WASTE MANAGEMENT PLAN

SOLID WASTE RECYCLING AND MANAGEMENT PLAN
(To be Submitted and Approved Prior to Commencement of Work)

Project: Demolition of Existing Athletic Center and Construction of New Athletic Center
Project Phase: Demolition

Owner: St. Paul's School
Street Address: 325 Pleasant Street
City, State, Zip: Concord, NH 03301
Phone: Fax: Email:
Contact: Phone:

General Contractor: Gilbane Building Company
Street Address: 325 Pleasant Street
City, State, Zip: Concord, NH 03301
Phone: 781-737-1500 Fax: 781-737-1550 Email:
Contact: Phone:

Architect: Architectural Resources Cambridge
Street Address: 140 Mount Auburn Street
City, State, Zip: Cambridge, MA 02138
Phone: 617-547-2200 Fax: 617-547-7222 Email:
Contact: Phone:

Date Submitted: July 11, 2003 Prepared By: John Gundling
The Institution Recycling Network
7 South State Street
Concord, NH 03301
603-229-1962 / fax 229-1960
Email: jgundling@ir-network.com

WASTE MANAGEMENT GOALS:
This project will recycle, reuse, or salvage at least 75% of the waste generated on site to earn 2 LEED points. Estimate and Maintain Recycling/Landfill Diversion Rates and Cost Benefit Analysis, Recycling vs. Disposal. (See Appendix)

COMMUNICATION PLAN

- Waste prevention and recycling activities will be discussed at each job site safety meeting with Gilbane Building Company employees and subcontractors. (See Appendix)
- All contractor and subcontractor employees will be notified of this plan and will be expected to comply with the plan
- All contractor and subcontractor foremen will receive a copy of this plan
- All subcontracts for this project clearly specify that adherence by subcontractors with this waste management plan is mandatory
- Any incidence of contamination by subcontractor of materials designated by this plan for source-separated recycling will result in a $750.00 fine (per subcontracts).

RECYCLING AND WASTE MANAGEMENT PROCEDURES

SAL	Salvage
CRUSH-ON	On-site crushing and reuse (asphalt, block, brick, concrete)
CRUSH-OFF	Removed from site for off-site crushing and reuse
SSR	Source-separated recycling
MDR	Mixed debris recycling
DISP	Disposal (recycling alternative not feasible)

SOLID WASTE RECYCLING AND MANAGEMENT PLAN

Project: Demolition, St. Paul's School Athletic Center

Material	Procedure	Market	Mgmt Plan	Estimated Quantities (if available)	
				Quantity	Units
Soils, foundation fill					
Ledge					
Asphalt					
Block	CRUSH-OFF		Source separate, crush off-site and recycle as aggregate	54000	1080 ton
Concrete w/ Rebar	CRUSH-OFF		Lower Level Floor, crush off-site and recycle as aggregate	370 cu yds	555 tons
Concrete w/o Rebar	CRUSH-OFF		Foundation, crush off-site and recycle as aggregate	460 cu yds	690 tons
Windows	N/A				
Doors, Interior	SAL				
Doors, Exterior Steel	SAL				
Backboard Frames, 6	SAL				
Steel I-Beams 36", 4	SAL				
Bar Joists 24"	SAL				
Bar Joists 16"	SAL				
Bar Joists 12"	SAL				
Metal, Ferrous	SAL, MDR				
Metal, Nonferrous	SAL, MDR				
Porcelain fixtures	SAL				
Metal, Wiring	SAL, MDR, SSR		Best method to be determined by owner, contractor, & sub		
Elec Serv.	SAL				
Lockers	SAL, MDR		Best method to be determined by owner, contractor, & sub	500	10 tons
Bleachers, 15 sets	MDR				
Wood (clean)	SSR, MDR		Best method to be determined by owner, contractor, & sub		
Wood (stained, painted)	SSR, MDR		Best method to be determined by owner, contractor, & sub		
Wood (PT)	N/A				
Drywall (painted)	DISP		This material cannot be recycled and must be disposed of		
Drywall (clean)	N/A				
Glass, ¼" plate	SSR, MDR		Best method to be determined by owner, contractor, & sub	350 sq. ft.	.6 tons
Mirrors ¼" plate	SSR, MDR			800 sq. ft.	1.4 tons

SOLID WASTE RECYCLING AND MANAGEMENT PLAN

Project: Demolition, St. Paul's School Athletic Center

Roofing, Shingles	N/A				
Roofing, Membrane	SSR, MDR				
Roofing, Other	N/A				
Tectum Decking	DISP		This material cannot be recycled and must be disposed of		
Plaster over wire	DISP		This material cannot be recycled and must be disposed of		
Trash, Solid Waste	DISP		This material cannot be recycled and must be disposed of		

SOLID WASTE RECYCLING AND MANAGEMENT PLAN **PRELIMINARY LANDFILL DIVERSION RATE CALCULATION**	
Estimated Tons to be Salvaged, Reused and Recycled	2,500
Estimated Tons to be Disposed	500
Total Tons Generated	3,000
Landfill Diversion Rate (Recycled Tons/Generated Tons = Diversion Rate)	83%

SOLID WASTE RECYCLING AND MANAGEMENT PLAN, APPENDIX A,

COST BENEFIT ANALYSIS, RECYCLING VS DISPOSAL

Project: Demolition, St. Paul's School Athletic Center

Material	Quantity (Tons)	Estimated Tip Fee, Recycling	Estimated Trans. Recycling	Total Estimated Recycling Cost	Estimated Cost Disposal	Estimated Savings
Landclearing Debris						
Timber						
Limbs, Brush						
Soils, foundation fill						
Ledge						
Asphalt						
Block						
Concrete w/ Rebar						
Concrete w/o Rebar						
Windows						
Doors, Interior						
Doors, Exterior Steel						
Backboard Frames, 6						
Steel I-Beams 36", 4						
Bar Joists 24"						
Bar Joists 16"						
Bar Joists 12"						
Metal, Ferrous						
Metal, Nonferrous						
Porcelain fixtures						
Metal, Wiring						
Elec Serv.						
Lockers						
Bleachers, 15 sets						
Wood (clean)						
Wood (stained, painted)						
Wood (PT)						
Drywall (painted)						
Drywall (clean)						
Glass, ¼" plate						
Mirrors ¼" plate						

SOLID WASTE RECYCLING AND MANAGEMENT PLAN APPENDIX A

COST BENEFIT ANALYSIS, RECYCLING VS DISPOSAL

Project: Demolition, St. Paul's School Athletic Center

Material	Quantity (Tons)	Estimated Tip Fee, Recycling	Estimated Trans. Recycling	Total Estimated Recycling Cost	Estimated Cost Disposal	Estimated Savings
Roofing, Shingles						
Roofing, Membrane						
Roofing, Other						
Tectum Decking						
Plaster over wire						
Trash, Solid Waste						

SOLID WASTE RECYCLING AND MANAGEMENT PLAN ESTIMATED RECYCLING vs. DISPOSAL CALCULATION	
Total Estimated Recycling Cost	
Estimated Cost of Disposal	
Total Savings Vs Disposal	
Savings to be derived from Recycling vs. Disposal (%)	

SOLID WASTE RECYCLING AND MANAGEMENT PLAN, APPENDIX B,

RECYCLING MEETINGS AND AGENDA

Project: Demolition, St. Paul's School Athletic Center

APPENDIX
RECYCLING MEETINGS

The Institution Recycling Network was retained by St. Paul's School to develop and oversee the implementation of a Solid Waste Recycling and Management Plan compatible with LEEDS 2.1 recycling objectives. The objective of all parties concerned is to secure the two credits available for recycling 75% or more of the project's waste materials. The IRN was retained by St. Paul's School, after timber harvesting and initial site work, and just prior to the commencement of demolition activities. The following recycling meeting agenda reflects the IRN's involvement after being retained by St. Paul's School, but does not reflect prior discussions and recycling decisions made earlier between Gilbane Buildingt Company, St. Paul's School, the architect and demolition sub-contractor.

1. Pre-Demolition

Gilbane Building Company, IRN, St. Paul's School, and/or Architect will conduct a pre-demolition meeting to review recycling objectives for the demolition phase of the project. Recycling materials will be identified and proposed recycling techniques to be required in the Solid Waste Recycling and Management Plan will be reviewed for each material. Job-site recycling activities and objectives will be reviewed and final end-market determinations will be made. The Solid Waste Recycling and Management Plan will be adjusted to reflect the above determinations. Recycling methodology and handling/storage techniques will be determined

2. On-going Recycling Meetings

Gilbane Building Company and the IRN will conduct Recycling Meetings concurrent with demolition activities to evaluate performance versus objectives of the Solid Waste Recycling and Management Plan.

3. Post-demolition

Gilbane Building Company, IRN, Demolition Contractor, St. Paul's School, and/or Architect will conduct a post-demolition meeting to review Solid Waste Recycling and Management Plan and evaluate demolition contractor's and sub-contractors' compliance with the goals and objectives of the Solid Waste Recycling and Management Plan, to make any necessary adjustments to the Solid Waste Recycling and Waste Management Plan and discuss recycling methodology, handling, storage, end-market, and transportation activities successes and failures for future projects

SOLID WASTE RECYCLING AND MANAGEMENT PLAN, APPENDIX B,

RECYCLING MEETINGS AND AGENDA

Project: Demolition, St. Paul's School Athletic Center

RECYCLING/TRAINING MEETINGS AGENDA

1. Involve Subcontractors

We will take steps to ensure that the subcontractors will participate in the successful implementation of the Solid Waste Recycling and Management Plan:

- Require subcontractors to use the recycling and disposal bins on-site. In doing so, we ill be sure to provide recycling for the variety of wastes the subs generate.
- Alternatively, we will ask the subcontractors to recycle their own waste on their own, but we will require documentation of their efforts.

2. Promotion and Education

Once we have designated a space for recycling and disposal activities, we will communicate our plan to the crew and subcontractors. They will need to know how materials should be separated, where materials should go, and how often the materials will be collected and delivered to the appropriate recycling/disposal facilities. We will educate our team to:

- Include waste handling requirements in all project documents. Make it clear from the beginning that waste prevention and recycling is expected from all crew members and subcontractors.
- Let the crew and subcontractors know how effective they have been by regularly posting the weights of material reused or recycled.
- We will include everyone in the process. We will encourage suggestions for more efficient recycling methods, or additional materials that can be recycled.

3. Preventing Contamination

Our recycling efforts may be in vain, if our recycling loads get mixed or contaminated with garbage. Haulers and recyclers won't take contaminated materials, which could cost us extra in disposal fees. We will prevent recycling contamination:

- Place posters with information describing the recycling program in visible locations
- Provide handouts describing our recycling goals and objectives to all employees and subcontractor team members.
- Clearly label the recycling bins. Post lists of materials that are and are not recyclable.
- Place recycling and trash bins near each other so that trash is not thrown into recycling bins.
- Conduct regular site visits to verify that bins are not contaminated. Give feedback to the contractors and the crew on the results of their efforts
- Provide rewards (ie. tee-shirts) for effective recycling and penalties ($750.00) for contamination.