Setting Up for Recovery of Construction and Demolition Waste

Community solid waste managers and private companies alike are finding benefits in recovery and reuse of construction and demolition waste. This article characterizes C&D waste and profiles how some facilities are setting up to process it.

By Richard M. Schlauder and Robert H. Brickner

Most construction and demolition waste is considered part of the municipal solid waste stream and is disposed of in municipal landfills. Some of these landfills are specially permitted C&D landfills having less stringent construction standards than MSW landfills. But management of C&D is rapidly changing.

As part of the trend encouraging recycling and reuse, and because of rising disposal costs, communities and contractors are increasingly targeting C&D waste for management other than by disposal. A growing number of public and private organizations are instituting programs to separate C&D for recycling or other reuse projects. And, because more segregated materials are available from a wide range of C&D recovery activities, a growing number of companies are developing facilities to commercially recycle the materials generated.

There are a few key reasons for the new emphasis on alternative management of C&D waste. C&D waste is a target because it is both heavy and bulky, and therefore undesirable for disposal in landfills. On the other hand, many C&D materials have high potential for recovery and reuse. Recovering C&D waste can help communities reach their recycling goals and preserve space in their local landfill. For private companies who generate the waste, separating out some useful materials enables them to avoid a portion of disposal tip fees.

Rick Schlauder is a senior project manager and Bob Brickner is a senior vice president for Gershman, Brickner & Bratton, Inc. a solid waste management consulting firm.

Table 1: Composition of C&D Waste (by percent).

Constituent	*Roadwork Material*	*Excavated Material*	*Building Demolition Waste*	*Renovation Waste*	*Mixed Site Clearance*	*Total*
Asphalt	23.4	0.0	1.6	0.0	0.1	2.22
Concrete	46.4	3.2	20.0	8.0	9.2	14.67
Reinforced concrete	1.6	3.0	33.1	8.3	8.3	16.46
Dirt, soil, mud	16.8	48.9	11.8	16.1	30.6	23.84
Rock	7.1	31.1	6.8	7.8	9.7	11.53
Rubble	0.0	1.4	4.9	15.3	14.1	7.72
Wood	0.1	1.1	7.1	18.2	10.5	7.90
Sand	4.6	9.5	1.4	3.2	1.7	3.17
Metal (ferrous)	0.0	0.5	3.4	6.1	4.4	3.29
Block concrete	0.0	0.0	1.1	1.1	0.9	0.80
Brick	0.0	0.3	6.2	11.9	5.0	5.18
Glass	0.0	0.0	0.2	0.8	0.6	0.32
Other organics	0.0	0.3	1.3	2.6	3.1	1.71
Plastic pipe	0.0	0.0	0.6	0.4	1.1	0.60
Trees	0.0	0.7	0.0	0.0	0.1	0.15
Fixtures	0.0	0.0	0.1	0.0	0.1	0.02
Miscellaneous	0.0	0.0	0.1	0.1	0.2	0.11
Bamboo	0.0	0.0	0.3	0.1	0.3	0.21
Total	100%	100%	100%	100%	100%	100%

Source: Hong Kong C&D Waste Recycling Report, April 1991, compiled by Donohue/JRP Asia Pacific Ltd. in association with GBB, Inc.

C&D waste is also a target for alternative management because it is conspicuous. It can make up a significant portion—roughly 15 to 20 percent—of a community's waste stream. Unlike paper, which comprises 37.5 percent of the MSW stream (by weight) and is tossed into the garbage stream by every waste-generating source (residents, businesses, industry), C&D waste is typically generated by a few, easily identifiable sources (construction contractors).

C&D Waste Composition

Although C&D waste is generally considered to be a single waste for management purposes, it is typically generated in two distinct streams. Most construction waste is associated with new construction and is usually identifiable; it is typically hauled to disposal sites in large roll-off containers full of building material scrap. Demolition debris is typically associated with the destruction of old structures and is often less easily distinguishable because of a greater variety of materials.

C&D Waste in Hurricane Andrew

Catastrophic events and natural disasters can significantly effect a community's C&D waste generation. A prime example is Hurricane Andrew, which struck south Florida in 1992, and generated the equivalent of a year's C&D debris for the entire state of Florida in a matter of a few hours. Published reports estimate the hurricane destroyed 75,000 homes. Based on an estimate of 30 tons of debris for each home, the hurricane generated approximately 2.25 million tons of demolition debris. There will also be additional construction waste generated in the rebuilding of these homes; it is estimated that this waste will be about 250,000 tons.

The disposal of this total 2.5 million tons of material will be costly. Landfill tipping fees in the Florida average about $40 per ton (ranging from more than $100 per ton in Monroe County to less than $20 per ton in Walton County). Using the average, the cost to dispose the 2.5 million tons of C&D waste generated by Hurricane Andrew will be about $100 million.

For ease of analysis, construction and demolition activities can be placed into one of five categories: roadwork, excavation, building demolition, construction/renovation, and site clearing. A list of the typical components most commonly found in each of the five categories is shown in Table 1. Although this table is based on data obtained from a C&D waste-composition study conducted for the Hong Kong government,[1] it illustrates the general composition of each of the five categories. Knowing these components, a landfill or recycling site operator can usually categorize the material in a vehicle into one of these five groups.

C&D Waste Quantity

One of the most difficult questions to answer about C&D waste is "How much is there?" Unlike MSW, which tends to have relatively well-established generation rates, C&D waste generation is highly variable because it is affected by many factors, most of which are beyond the control of C&D waste generators. These factors include:
—season and climate;
—strength of national economy (growth creates C&D waste);
—decisions on repairs of municipal infrastructure (roads, bridges, underground utilities);
—development of urban renewal projects; and
—catastrophic events, such as earthquakes, fires, floods, tornadoes, and hurricanes. (See accompanying box for the effect that Hurricane Andrew had on C&D waste generation).

As a result of this uncertainty, few generation estimates for C&D waste for the U.S. have been developed. Those that exist are vague or vary widely. For instance, the generation rates published in one report range from 0.12 to 3.52 pounds per person per day.[2] This represents a variation between potential quantities generated of about 30 times. In Pinellas County, Florida, where haulers have the option of taking C&D waste to a recycling facility near the MSW landfill, the county estimates C&D generation is about 1.8 pounds per person per day.[3]

To realistically project the quantity of C&D waste generation for an area, the recommended steps in the methodology include:
—Determine specific materials to be included in the C&D waste stream, based on the state definition.
—Interview the major generators of C&D waste according to this definition, including general building contractors, wreckers, land clearing contractors, and bridge building companies). The interviews should determine historical quantities and composition of C&D generated by the business.
—Beyond the contractor trades, identify the types of businesses and industries that generate C&D waste. Classify these generators by Standard Industrial Classification (SIC) Code, noting the number of firms in each category as well as the total employment in each company.
—With the input from all known generators, identify which C&D waste materials are generated in the largest amounts.
—Survey and quantify loads of C&D material coming into local disposal facilities in roll-offs and/or dump trucks.

Table 2: Typical Unit Purchase Costs for C&D Processing Equipment*

Equipment	*Cost Range*
Vibrating feeders	$ 30,000 - 40,000
Trommel screens	200,000 - 250,000
Primary crusher	300,000 - 350,000
Secondary crusher (impactor or cone crusher)	300,000 - 425,000
Magnetic separators	25,000 - 40,000
Vibrating screen (3 decks)	80,000 - 100,000
Conveyor belts ($320 to $500/ft)	50,000 - 150,000
Sink-float tank	75,000 - 150,000
Destoners	100,000 - 150,000
Front-end loader	100,000 - 200,000
Excavator attachments:	
• Shears	20,000 - 200,000
• Concrete pulverizer	20,000 - 50,000
• Grapples	10,000 - 30,000
• Impact hammers	
—Small/Medium	5,000 - 30,000
—Large/X-Large	50,000 - 150,000
• Rotary screen	20,000 - 100,000

* Suitable for systems to process 150 to 250 tons per hour; in 1992 dollars, excluding freight and installation.

To determine how much of the C&D waste stream is available for recycling, for use as a fuel, or for processing before landfilling, it is also critical to find out how much of the material generated is removed by source-separated activities before it enters the waste stream. You can gauge this information from the interviews you conduct as well as from comparing the total generation estimates to information gathered at the disposal facilities.

Techniques to Recycle C&D

Several types of facilities and equipment exist to process C&D waste materials into reusable, and marketable products. Below is a discussion of three types of C&D waste processing facilities and equipment arrangements that have been developed.

Concrete/Asphalt Crushing Plants

Concrete/asphalt crushing and screening processing systems utilize three principal types of size-reduction units. These units include jaw crushers, impactors, and cone crushers. The adaption of rock-crushing and sizing equipment for concrete crushing is proven around the world and several equipment manufacturers have years of experience to draw upon.

Several complementary pieces of equipment (e.g., the primary crusher feeder, magnetic separator, vibrating screens for product sizing, and several belt conveyors) form the typical processing system. This equipment downsizes and separates materials into useable aggregate products. For instance, concrete recycling reduces the need for virgin materials—which are depleted in some areas. Recycled asphalt fills a demand in certain areas for feedstock into new asphalt projects.

The Fresh Kills Landfill on Staten Island in New York City has a construction waste recycling facility that began operation in 1990. It recovers construction waste materials from projects undertaken by several municipal departments. These materials were formerly disposed of in the landfill. The overall site area is about 5.5 acres, which includes a waste receiving and product storage area. The system can process between 150 and 200 tons per hour of materials.

Incoming material consists of clean (free of organics), broken concrete, and asphalt with associated dirt. This material is fed by a front-end loader onto a vibrating feeder, which directs material into a jaw crusher. Crushed material passes under a magnet suspended over the outfeed belt, which removes ferrous metals. This is followed by a 6-foot by 10-foot triple deck vibrating screen for primary separation into aggregate sizes. Other auxiliary equipment includes a pedestal-mounted impact hammer and three mobile stacking conveyors.

All of the crushed C&D waste is recycled for use in the construction of the landfill. Smaller aggregate material (less than 1.25 inches) is used as cover or sub-base, while intermediate size material (1.25 to 2.5 inches) is used for sub-base or aggregate in drainage lines, and larger material (2.5 to 6 inches) is used for temporary roads.

Mixed C&D Waste

Some facilities are designed to process mixed C&D material—that is, material from several or all five C&D categories that arrives in the same load. Mixed C&D waste processing facilities typically utilize a blend of mechanical processing and manual sorting of the mixed materials. Depending on the markets being served, the mixed C&D waste delivered may be manually sorted rather than mechanically processed at a plant, particularly if a load is high in only one constituent.

Mixed C&D waste processing systems use various mechanical separation devices (e.g., trommel screens and disc screens) in conjunction with dry or wet processing separators. These dry or wet processes are used to separate organic or mineral materials. Dry processing systems that utilize air separators require the use of a cyclone baghouse or bio-filter control system to properly treat and dispose of dust. In wet processes, the heavy fraction, rich in inorganic materials, sinks to the bottom of the wet quench tank. The organic materials tend to float, so they can be removed in the wash water. When only water is used as the separation media, these units are commonly referred to as float-sink tanks.

One of the largest operating C&D processing facilities is the Star Recycling system in Brooklyn, New York. The privately-owned system, designed and built as a turnkey plant by Lindemann Recycling Equipment, is processing about 2,500 cubic yards per day of C&D waste using the following equipment:

—two in-line Mayfran feed conveyors,

—a 7-foot diameter Lindemann trommel, which separates fines of dirt-like material from larger rock, stone and concrete materials. The four-section trommel is more than 26 feet long with sizing holes ranging from 2 inches in the initial section to 6 inches. The most important aspect of this trommel (and any that are employed to process C&D waste) according to Louis Perez of Lindemann, is that "It's really heavy-duty. They have to be built like a battleship to handle rocks, beams, poles—all kinds of scrap. The environment is much harder than other MSW and MRF applications."

—a 60-foot long picking belt with eight chutes leading into 40 cubic yard roll-off containers. Pickers pull off organics, cardboard, wood, plastics, and light metals. Rocks and concrete is negatively sorted, and discharged into containers for transport to a rock crusher plant.

—a large front-end loader for pushing material onto an adjacent pile so that a track-operated grapple could deposit it either onto the feed conveyors, or if oversize bulky waste, into roll-off boxes for metal, large concrete, etc.

Wood Waste Facilities

If enough wood waste is generated

Table 3: Potential Products from C&D Waste

Material	Products and Applications
Asphalt:	Crushed and mixed with new asphalt — Hot mix — Cold mix
Concrete:	Crushed and screened aggregate — Road subbase — Asphaltic concrete — Concrete — Cement blocks — Fill
Dirt:	— Soil — Landscaping — Landfill cover
Metal:	
Aluminum	Scrap metal dealers, smelters
Appliances/white goods	Scrap metal dealers
Copper and other "red" metals	Scrap metal dealers
Ferrous pipes, sheet, rebar, plate, etc.	Scrap metal dealers
Wood:	
Untreated	— Timber — Wood pulp — Fuel — Landscaping mulch — Compost bulking agent — Animal bedding — Manufactured building products
Treated, Painted	Same as untreated wood, but potentially unacceptable per hazardous waste standards
Other:	
Brick	Crushed for ornamental stone
Fiberglass	(None known)
Glass	Reuse, fiberglass insulation, sand blast, reflective beads, aggregate in asphalt
Gypsum	Soil amendment, gypsum board, absorbent media
Plastic — ABB — PVC — Polyethylene — Polystyrene	 — Plastic lumber — Highway barriers — Traffic cones — Insulation
Porcelain	Aggregate
Old corrugated containers	Paper stock dealer; paper mill; fuel pellets
Carpet	Landfill cover
Fuel storage tanks	Reuse after cleaning; scrap metal
Linoleum	(None known)
Roofing shingles	Asphalt paving

areas or to wood-burning power plants for use as fuel; humus from the primary processing line is distributed as potting mix. Clean mulch (produced from primary and secondary processing) is used for horse trails and golf course cart paths; clean humus is sold to nurseries. The revenues from marketing these products is not substantial. The real value of the system to Winzinger is the savings from avoided disposal costs.

Costs

Costs associated with the recycling of C&D waste vary greatly depending on the type of process and volume of material. Costs consist of land, site preparation, buildings, equipment, installations, rolling stock, engineering and design, start-up, and contingencies. These costs are common to many processing operations, but the equipment is specific. Table 2 shows typical unit purchase prices for equipment used in C&D waste recycling.

In order to have an economically feasible project, the costs associated with C&D waste recycling facilities must be offset by project revenues. The revenues from C&D waste processing come from two sources: (1) tipping fees charged for the disposal of C&D waste at the facility; and (2) sale of recovered products by the facility. The upper limit tipping fee a facility can charge is usually set by competing MSW landfills, and the transportation costs associated with disposal in local MSW landfills or C&D waste landfills. The upper market value of the recovered materials will be limited by the costs of locally available virgin materials that recycled C&D products will replace. Buyers will expect to purchase materials recovered from C&D waste at a reasonable discount from the virgin materials.

Marketing of Recovered Materials

Products generated by C&D waste recycling programs can generally be categorized as inert granular products, wood waste products, and ferrous metals. Table 3 shows potential markets for materials recycled from each of the key waste categories. Securing market commitments for specific recycled products will play a significant part in ensuring a successful project.

Conclusion

With more end-use markets accustomed to buying substitute materials from recovery programs, and with more experience with processing C&D waste, C&D waste recycling is becoming a cost-effective alternative for managing of this component of the MSW stream. Also, it can assist communities in achieving legislative goals for landfill diversion and recovery of materials. As disposal costs continue to escalate nationally and states continue to set recycling goals, implementation of C&D waste recycling systems likely will continue to increase as well. □

Mr. Schlauder can be contacted at Gershman, Brickner & Bratton, Inc., 1104 Fernwood Ave., Suite 501, Camp Hill, PA 17011; (717) 975-0528. Mr. Brickner can be contacted at GBB, 2735 Hartland Rd., Falls Church, VA 22043; (703) 573-5800.

Notes:

1 "Study on Recycling of Construction Waste Received at Landfills," Donohue/JRP Asia Pacific Ltd., in association with Gershman, Brickner & Bratton, Inc., March 1992.

2 "Characterization of MSW in U.S., 1960-2000," prepared for U.S. EPA, by Franklin Associates, July 1986.

3 Lee, B., "New Style MRFs Recycling Construction & Demolition Waste," *Solid Waste & Power*, October 1991, page 45.