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On-Site Grinding of Residential Construction Debris: The Indiana Grinder Pilot

Prepared by the NAHB Research Center

The objective of the pilot project was to determine the feasibility of on-site grinding of clean wood, drywall, and cardboard waste from new residential construction as an alternative to conventional landfilling. The evaluation included the identification and assessment of the major technological, economic, and environmental factors associated with the grinding technique. The pilot project was established near Indianapolis, Indiana through funding provided by the Indiana Department of Environmental Management and the United States Environmental Protection Agency. The Builders Association of Greater Indianapolis played an important role in the organization and administration of the project, which involved several local businesses including residential builders and a waste management firm.

This preliminary report includes the following:

- a summary of the *technological feasibility*, including a description of the grinder and it's performance;
- a summary of the *economic feasibility*, including an economic analysis which considers the sensitivity of results to key variables such as labor rates, tipping fees, and transportation costs;
- draft *guidelines for the on-site application of the material*; and
- an educational *fact sheet for home buyers*.

Project Background

An estimated 136 million tons of building-related construction and demolition (C&D) debris were generated in 1996 in the United States. It is estimated that residential construction, at the rate of roughly 4 tons per house, generated over 6.5 million tons (approximately 5 percent of this C&D total) in 1996. Detailed waste assessments have determined that approximately 75 percent of this waste stream consists of wood, drywall and cardboard, and another 10 percent is also potentially recyclable.

In many regions of the United States the weak demand for many recyclable construction waste materials, combined with the high cost of transportation, results in few cost-competitive alternatives to conventional landfilling. With the recent design and development of specialized mechanical equipment, one promising alternative is grinding the wood, drywall, and cardboard scraps and reusing the processed material on-site as a soil amendment and for erosion control, and/or off-site as a feedstock for mulch and compost products.

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Technological Feasibility

Grinder Description

The grinder used in the pilot was a top-loading, low-speed, horizontal-drive grinder manufactured by Concept Products Corporation of Paoli, Pennsylvania under the name "Shred-All". The shredding mechanism of the Shred-All is a low-speed (28-80 RPM), six foot long, auger-shaft with 35 replaceable teeth, which is powered by a 125 horsepower John Deere diesel engine. The dual-axle, grinder-trailer assembly measures 8'-0" long and 6'-0" wide and weighs approximately 8000 pounds, and can be pulled with one-ton pick-up truck.

The bottom of the loading hopper is roughly 6 feet above ground, allowing the machine to be loaded manually. The optional hopper extension expands the capacity of the hopper to 2.5 cubic yards. The optional in-line conveyor is 9 feet long and equipped with an electric winch allowing the delivery of output to a variety of heights.

Grinder Performance

In general the grinder performed well and provided the opportunity to fully explore the other objectives of the pilot project, i.e., the economic and environmental feasibility. Specific results are listed below.

- *Throughput* - The average throughput of the machine was approximately 10 cubic yards/hour for wood and slightly higher (10.5 to 11 cubic yards/hour) for drywall and cardboard.

- *Volume reduction* - Wood volume was reduced approximately 50 percent, and drywall was reduced 60 percent.

- *Particle size* - Approximately 80 percent of the processed wood was less than 2-inches in size. The gypsum in the drywall was essentially processed into dust, and the paper facing was processed into 3-inch or minus.

- *Loading* - Wood particles up to six-inches wide were fed into the grinder. Odd-shaped pieces of structural sheathing and long pieces of 2x material required careful loading to avoid jamming and/or flying debris.

- *Safety* - The grinder operators reported no injuries and stated that the equipment was safe to operate. The grinder operates at low-speeds, and the bottom of the loading hopper is approximately four feet above the auger and six feet above ground. The grinder is equipped with an emergency kill switch.

Economic Feasibility

The total cost of various grinding and landfilling services are projected and compared in Table 1. It is important to note that these represent costs to the *owner/operator of the equipment* (which could be the builder or a subcontractor). Table 1 presents the costs based on experiences in the pilot project, and also extends the economic analysis to consider the sensitivity of results to key variables such as labor rates, tipping fees, and transportation costs. Analysis of the information provided in Table 1 suggests the conclusions listed below.

Table 1. Cost Comparison of Services & Sensitivity Analysis

Service Type	Cost For Service ($/House)[1]			
	Pilot Project Conditions	With Lower Tipping Fees[2]	With Lower Labor Rates[3]	With Longer Travel Distances[4]
Grinding for production builders only[5]	660	570	560	690
Grinding for custom & production builders[5]	770	680	660	860
Landfilling with roll-off trucks and dumpsters	810	450	810	870

Assumptions:

1. The cost has been rounded to the nearest $10
2. A tipping fee of $6/cubic yard (the pilot project conditions used $12/cubic yard).
3. A labor rate of $10/hour for debris-loading tasks, i.e., loading grinder and stake body truck (the pilot project conditions used $20/hour).
4. A travel distance of 20 miles from shop to sites, 20 miles from site to site (for custom sites) and 20 miles each way to landfill/transfer station (the pilot project conditions used 10 mile distances).
5. All processed material, i.e., by the grinder, utilized on a nearby site.

- *Overall economic feasibility.* The grinding service was more than cost-competitive with conventional landfilling given the pilot project conditions, i.e., moderately high tipping fees, modest labor rates, and low transportation costs. When serving production builders only (as opposed to serving custom *and* production builders) the grinding technique reduced the cost per house by $150, or 18 percent.

- *Impact of low tipping fees.* In conditions of lower tipping fees the grinding service would be competitive with conventional landfilling only when servicing production builders, i.e., with significantly less set-up/take-down and travel costs. In other words, conventional landfilling is highly sensitive to tipping fees, whereas grinding services are not. Tipping fees at the two local solid waste facilities permitted to accept construction and demolition debris (both transfer stations) were approximately $10/cubic yard and $14/cubic yard[1].

- *Impact of low labor rates.* A large percentage of the grinding service labor can be done by minimally-skilled workers, thereby reducing the cost of the service. Conventional landfilling with roll-off trucks and dumpsters requires a worker capable of driving and operating heavy equipment.

[1] Based on a conversion of 350 pounds per cubic yard (or 5.7 cubic yards per ton) for mixed construction debris from residential jobsites, the $12.00/cubic yard tipping fee is equivalent to $68.40 per ton.