To: Recipients of the SWMCB Construction Waste Project Final Report

From: SWMCB Staff

Subject: On-site grinding and beneficial reuse of construction waste

Date: June 1, 2003

The Construction Waste Project was conducted by the Solid Waste Management Coordinating Board to research, identify, coordinate and evaluate two construction waste demonstration projects in the Twin Cities Metropolitan Area. The demonstration projects focused on increasing source reduction, reuse and recycling and reducing the toxicity of construction waste landfilled in Minnesota.

The Project included a demonstration of the on-site grinding and beneficial reuse of untreated wood, concrete block, brick and shingles for a period of four months. As with any demonstration project, the methods were conducted under controlled circumstances. The Project required specific approvals from State, County and local agencies and was closely monitored by the Minnesota Pollution Control Agency (MPCA), County and local officials. Site personnel responsible for the on-site management and processing of materials were very well trained in this regard.

The findings of the on-site grinding and beneficial reuse demonstration project represent data from two specific sites, which may or may not be typical of the industry. Additional work has yet to be done to determine if the findings, including relative economics, could be applied as an industry-wide practice. Options discussed in the final report are not reflective of any SWMCB policy position but rather a forum for further discussion within the industry.

The MPCA will be considering the on-site grinding and beneficial reuse of construction waste as part of the process underway to revise the Minnesota Solid Waste Rules. In the meantime, the MPCA is evaluating additional requests to conduct on-site grinding and beneficial reuse of construction waste on a case-by-case basis. For more information, please contact John Elks, MPCA, at (651) 296-7334 or john.elks@pca.state.mn.us.
REPORT

CONSTRUCTION WASTE PROJECT

Prepared for:

Solid Waste Management
Coordinating Board

December 31, 2002

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URS Job Project Number: 49970-001
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EXECUTIVE SUMMARY

URS Corporation (URS) was contracted by the Solid Waste Management Coordinating Board (SWMCB) to research, identify, coordinate and evaluate two construction waste demonstration projects in the Twin Cities Metropolitan Area. The demonstration projects focused on increasing source reduction and recycling of construction waste in Minnesota and reducing the volume and toxicity of construction waste landfilled. This is the “final report” produced for this project. Earlier in the project, “Memo #1,” was issued, which included background research for the demonstration projects. Memo #1, presented in Appendix A, estimated the amount of construction waste produced in the SWMCB area, identified recycling and waste reduction options for construction waste, examined potential opportunities for construction waste and existing situations, examined existing regulatory framework for construction waste, assessed local markets and feasibility, solicited feedback from government entities and industry, and recommended two construction waste demonstration projects. The two demonstration projects are the focus of the final report. Descriptions and evaluations of the two projects as well as recommended actions are presented in this report.

The scope of services for both demonstration projects were developed based upon the following Minnesota waste management hierarchy:

- Reduce/minimize waste generation;
- Reuse materials for their original intended purpose;
- Recycle materials for other use; and
- Dispose of remaining materials.

Project partners included SWMCB Commissioner Dennis Hegberg and the following SWMCB staff: Jan Lucke (Richardson Richter & Associates), Michael Reed (Ramsey County), and Sheila Weigman (Dakota County). Other primary project participants included Marcus Zbinden and Brad Hanzel (Carver County); Peter Bierman, PhD (University of Minnesota); Aaron Mlynek (Carver County Soil and Water Conservation District); Keith Peterson (Construction Waste Solutions); Kevin Peterson (Construction Debris Management); Pulte Homes; John Elks, Mike Martindale and Scott Fox (Minnesota Pollution Control Agency); Wayne Gjerde (Minnesota Office of Environmental Assistance); Jason Haus (Dem-Con Companies, LLC); Kevin Johnson, Lindquist & Vennum, P.L.L.P; Tim Townsend, PhD and Jenna Jambeck (University of Florida); and Sabina Ylinen (URS).

Demonstration Project Number 1

The purpose of Demonstration Project Number 1 was to explore the technological feasibility, cost effectiveness, environmental soundness and regulatory issues associated with on-site grinding and the beneficial reuse of construction wastes. Source separated untreated dimensional lumber, oriented strand board (OSB), plywood, gypsum drywall, shingles, brick, and small quantities of unrecyclable cardboard and paper packaging were evaluated for beneficial reuse on-site. Some of these materials were permitted by state and local environmental agencies to be ground and land applied at construction job sites as erosion control and driveway base. In addition to evaluating on-site application, construction waste reduction, reuse and recycling
options were explored in order to reduce the volume and toxicity of the construction waste stream. Partners in this demonstration project include Construction Debris Management (CDM), the Packer Industries on-site grinder representative; Construction Waste Solutions (CWS), the on-site service provider and grinder operator; and the production builder, Pulte Homes.

The primary goal of this project was to evaluate the actual on-site grinding process; however, it was critical that proper regulatory approval be obtained from all state and local agencies before commencing. The environmental regulatory approval process for this demonstration project took longer than expected, but the experience provided valuable information that may be beneficial to apply to other projects.

As part of the approval process, a document describing the details of the demonstration project was submitted to the Minnesota Pollution Control Agency (MPCA). The document was prepared by SWMCB staff, including Jan Lucke of Richardson Richter & Associates, Michael Reed of Ramsey County, Sheila Wiegman of Dakota County, and Kevin Johnson, Lindquist & Vennum, P.L.L.P. Input from others included Marcus Zbinden and Brad Hanzel of Carver County; Keith Peterson of CWS; Kevin Peterson of CDM; Tim Townsend, PhD and Jenna Jambeck of the University of Florida; Peter Bierman, PhD, of the University of Minnesota; and Sabina Ylinen of URS. The application document included a description of the project goals, time frame, locations, participants’ roles and responsibilities, a solid waste management plan, a solid waste utilization plan, air quality data, public information, and necessary attachments and appendices. The MPCA verbally approved the grinding and on-site application demonstration project to begin in July 2002 and followed up with an approval letter. The MPCA approval letter and application document are presented as Appendix C. The MPCA approved this project as a demonstration project. There are no rules governing the beneficial reuse of solid waste. The MPCA is in the process of developing such rules, which should be available for public comment in 2003.

Pulte Homes, the nation’s largest homebuilder, was interested in exploring environmentally sound methods of construction waste management, and agreed to partner on the project. Pulte Homes construction sites participating in the on-site grinding and application project were Regatta Development in Apple Valley (Dakota County) and Arboretum Village, located in Chanhassen (Carver County). Initially a Pulte Homes site in Chaska (Carver County) was considered, but the construction was completed prior to project approval and start-up.

Another on-site grinding study was conducted concurrently with this demonstration project, but was outside the URS contracted scope of services. SWMCB and Dakota County evaluated the on-site grinding of construction materials and beneficial reuse at a Hans Hagen (panel-style production builder) site, in the City of Carver (Carver County). This project was conducted in parallel with the URS projects and under the same regulatory approval process. Dakota County’s report outlining the results of this study is provided in Appendix B.

Demonstration Project Number 1 was found to be cost comparable to the Pulte Homes previous method of construction waste management, which was use of local construction and demolition waste landfills. Specific financial information was not available due to proprietary concerns on the part of the on-site contractor.
Waste Reduction

Because of the flat fee charged for waste disposal at Pulte Homes construction sites, there is no existing financial incentive for the builder to recycle or reduce the amount of waste generated. For example, if two 30 cubic yard waste disposal containers are filled per home, and a flat fee is charged per container, the builder has no incentive not to fill the second container for every house, since they will pay the same rate whether the container is full or not. This flat fee rate actually encourages the customer (i.e. the builder) to fill waste containers. Existing purchasing practices pose another disincentive for waste reduction at the job site. Subcontractors are often provided the materials to do a job from the builder. The subcontractor does not pay for the purchase or disposal of materials, so there is no motivation to reduce, reuse or return unused materials to suppliers for credit. URS recommends a regulated pay-as-you-throw (by volume or by weight) payment option for construction waste disposal to encourage builders to reduce waste. Another option is to assign responsibility to the subcontractors for purchase and/or waste disposal of materials, which may encourage more efficient construction material management.

Reuse

A fair amount of material that is still usable and may be reused for its intended purpose is disposed by builders. An informal reuse process was developed by CWS. Materials that were intended for disposal were used by an employee of CWS to construct farm outbuildings. In addition, 46, 8-foot long, 2x4 boards were picked up for reuse by a manufacturer from St. Bonifacius, Minnesota. The manufacturer used the wood to construct custom pallets for their product. Types and amounts of material that was available for reuse included many sizes of dimensional lumber and particle board for roofing and flooring. URS recommends a common storage area at a construction site for materials that are still usable so they may be reused for their intended purpose by others. Materials could be given away or sold to employees, or even the subdivision residents. Used construction materials can be distributed and sold at used construction materials retailers in the Twin Cities Metropolitan Area (for example, there are retailers of materials obtained from systematic deconstruction of buildings). However, if waste is reduced in the first place and materials are properly ordered for the size of the job, there should be less unused material remaining at construction sites.

Recycling

Various construction materials were characterized, discussed and evaluated for beneficial reuse in Memo #1. The materials targeted for on-site beneficial reuse in this demonstration project were the following:

- Wood (solid sawn lumber and engineered wood);
- Drywall;
- Asphalt roofing shingles; and
- Concrete and brick.

Unacceptable materials for grinding and beneficial reuse included treated lumber, painted lumber, painted wallboard, moisture resistant wallboard, BiltRite (reuse wasn’t explored),
plastics, vinyl siding and mixed municipal solid waste. Pulte Homes arranged for these materials to be disposed by CWS or a local solid waste hauler.

It should also be noted that environmental regulatory approval was received to grind and beneficially reuse all of the materials listed above except for gypsum drywall. It was determined through soil sampling and analysis that the soils at the Pulte Homes construction sites in Chaska, Chanhassen, and Apple Valley would not be benefited from applying gypsum (Ca\(_2\)SO\(_4\)-2H\(_2\)O) as a soil amendment; therefore, the ground drywall could not be beneficially reused. Approval for land application of the gypsum drywall without beneficial reuse was not considered for this project, but could be possible with the proper permit and oversight of the MPCA.

Clearly marked, moisture-proof containers were placed at the demonstration project construction sites for collecting cardboard. CWS solutions reported that the cardboard collection and recycling was initially challenging, but proved to be successful and economical once the subcontractors were trained. The key for this type of recycling is correctly training the subcontractors, while keeping the process as easy as possible for them. CWS averaged 2.9 tons of cardboard per week from four Pulte Homes job sites and one Hans Hagen site. Cardboard was collected at the job sites and delivered to Rock-Tenn, a local recycling facility.

The materials that were ground and reused on-site primarily included solid sawn lumber, engineered wood, and pallets. Ground wood (mulch) can be used for erosion control, sediment control, temporary walkways on the job site, landscape mulch, tree root zone protection and as temporary splash protection for finished home exteriors (such as siding and brick). The focus of this project was to evaluate the use of ground wood material primarily as erosion and sediment control. Secondarily, the ground wood could be used for temporary walkways on the job site and landscape mulch. Some brick and shingles were also ground and recycled. Ground shingles, stone and other aggregate materials can be used as a substitute for Class 5 aggregate in driveway bases.

At the Chanhassen site from July through October, 78 housing units were framed. An estimate of waste generated by Pulte Homes is 45 cubic yards of waste per unit, which equals 3,510 cubic yards of total waste generated during that time period. 1,655 cubic yards of wood (both solid sawn lumber and engineered wood) was ground and beneficially used on-site. This diverted approximately 47% of the waste stream (by volume) from the landfill. In addition to the lumber waste, 157 wood pallets were ground and utilized. Another 2 cubic yards of brick from 6 housing units was ground for beneficial reuse.

At the Apple Valley site, a total of 36 housing units (at 45 cubic yards/each) were framed and 12 units “cleaned” of waste after construction was complete (11.25 cubic yards/each) during the time frame of the project, resulting in an estimated 1,755 cubic yards of construction waste. A total of 670 cubic yards of wood (both solid sawn lumber and engineered wood) were ground and beneficially used, diverting 38% of the waste stream (by volume) from the landfill. Another 153 pallets were ground and 2 cubic yards of shingles were ground and beneficially reused.
EXECUTIVE SUMMARY

Using a standard conversion factor of 300 pounds/cubic yard for wood, a total of 349 tons of solid sawn lumber and engineered wood was kept out of the landfills through off-site reuse and on-site beneficial reuse. This includes 310 pallets from the Chanhassen and Apple Valley sites.

Disposal

Residuals that were not reused or recycled were disposed. Both exterior gypsum drywall and treated wood were specifically removed from the waste stream and recorded for data analysis purposes. Interior drywall was disposed separately by the drywall subcontractor. A total of 14.25 cubic yards of treated wood and 286 cubic yards of exterior drywall were collected and disposed at the Chanhassen site (78 units). At the Apple Valley site (36 units framed, 12 cleaned), a total of 5.6 cubic yards of treated wood and 122 cubic yards of exterior drywall were disposed. Treated wood comprised approximately 0.4% of the waste stream while exterior drywall made up approximately 7.7% (by volume). Using a conversion factor of 500 pounds/cubic yard for drywall, 102 tons of exterior drywall was disposed. Treated lumber should be disposed at an MSW landfill.

Demonstration Project Number 2

The purpose of Demonstration Project Number 2 was to examine the many challenges affecting the success of a construction waste processing facility in the Twin Cities Metropolitan Area. It accompanies Demonstration Project Number 1 by continuing to identify benefits and barriers to source reduction and recycling of construction waste and reducing the volume and toxicity of construction waste landfilled in Minnesota. The partner on this demonstration project was South Metro Sort and Recycle, Inc. (SMS&R), located in Shakopee, Minnesota. Although SMS&R is located in Scott County, which is outside of the SWMCB area, it accepts waste from counties located in the SWMCB region, and is an important component of the construction debris management system in the Twin Cities Metropolitan Area. SMS&R, which commenced operations in 1999, falls into the recycling category of the Minnesota waste management hierarchy.

Since the MPCA does not issue permits for the removal of construction debris at a recycling facility, SMS&R holds a demolition/construction waste transfer facility permit. The primary purpose of the facility is to accept unsorted construction and/or demolition waste, sort the materials that may be recycled, and transfer the remaining unrecyclable materials to the landfill. The recyclables are stored on-site until enough accumulate to make it economical to transport and sell them. The facility is permitted to have three operating areas: (1) a solid waste recycling area, (2) solid waste transfer area and (3) a tire processing area. The following are the maximum permitted throughputs for the facility:

1. Municipal solid waste (disposed as residual) – 70 tons/year
2. Demolition/construction debris – 350 tons/day
3. White goods – 40 tons/year
4. Tires –12 tons/year
5. Recyclables – 8,000 tons/year
6. Batteries – 1 ton/year
At SMS&R, construction and demolition waste is unloaded onto the sorting floor and materials with ready markets are separated out by hand and the use of a skid steer. Any remaining material is sent to the adjacent Dem-Con Landfill or a mixed municipal solid waste (MSW) landfill, as appropriate. This is the simplest method of recovering mixed (non-source separated) construction waste. The equipment used at the site includes a cardboard baler, a metal baler, a wood shredder, alligator shears, a skid steer, and a front-end loader. On-site personnel typically consist of 4 to 5 employees.

**Current Recycling**

Although various other states have successful construction and demolition waste processing and recycling facilities, the focus of this study was to examine the existing industry conditions that affect the optimal utilization of the SMS&R facility in Minnesota. SMS&R is the leading materials recovery facility and only one solely dedicated to processing commingled construction waste in the Twin Cities Metropolitan Area.

SMS&R was able to recycle 35% of the material accepted at the facility (by volume) in 2001. In that year, over 102 tons of metal and 186 tons of cardboard were recycled. This is a significant portion of the waste stream, but additional recyclable materials, such as drywall, could be targeted. However, the examination of SMS&R revealed there are many challenges affecting the success of such a construction waste processing facility in Minnesota.

**Challenges**

SMS&R charges a lower tipping fee for source-separated materials and accepts waste on a volume basis because it does not have a weigh scale. This distinction affects the composition of the waste stream managed by SMS&R. Since construction waste and demolition debris is typically a large volume waste stream, it can be an economic disincentive to dispose of high volume/low weight material at a facility that charges by volume. SMS&R primarily receives shingles and drywall because these are low volume/high weight materials, which are more cost effective to dispose on a volume basis. Other recyclable materials like wood and cardboard, that are low weight/high volume, are commonly brought to other facilities that accept waste by weight; however, these facilities typically do not recycle to the same extent and may simply dispose of the materials. SMS&R has explored the possibility of installing a weigh scale, and has determined that SMS&R would not be competitive with the low per ton tip fee at other facilities.

Hauling and transportation distances, as well as competitive pricing of other facilities, have an affect on the amount of waste SMS&R receives. The service area of SMS&R is primarily from the southeastern section of Hennepin County, Carver County, Scott County and some sections of Dakota County. However, even though the hauling distance may be shorter to SMS&R, some solid waste haulers will bypass the facility and go further to another area landfill because of lower tipping fees and more liberal acceptance criteria. In the past 5 years, the amount of waste crossing state lines has increased. This is especially true in southern Minnesota where waste is often transported to Iowa and in eastern Minnesota, where waste is frequently transported to...
Wisconsin. In addition, some haulers which own transfer stations are hauling waste out-of-state because of lower tipping fees. This waste-flow trend includes construction debris being managed as MSW.

SMS&R has another economic disadvantage. Per Minnesota Statute 297H.04, commercial generators that generate nonmixed municipal solid waste shall pay a solid waste management tax of 60 cents per noncompacted cubic yard. The statutory requirements result in two inequities.

First, all material accepted at a construction and demolition waste processing facility is taxed regardless of whether the material is ultimately recycled or landfilled. Therefore, there is no tax incentive to process mixed loads of construction waste for recycling. Minnesota Statute 297H.06 provides for certain tax exemptions to encourage the recycling of MSW. Minnesota Statutes do not provide similar exemptions to encourage the recycling of nonMSW, such as construction waste.

Second, construction and demolition waste is often contaminated with MSW, which is separated and sent to an MSW landfill as residual. The waste is taxed a second time at the rate of 17% (Minnesota Statute 297H.03) upon being disposed as MSW, resulting in a double tax. This places an additional economic burden on SMS&R.

Carver County is conducting a pilot program that offers a financial incentive to solid waste haulers who recycle their construction waste rather than landfill it. Licensed haulers may enter into a contract with the county to receive a $2 per cubic yard subsidy for waste delivered to a processing facility such as SMS&R. Six haulers have actively participated in the subsidy program, and as of January 2002, a total of 7,077 cubic yards of construction material had been diverted from landfilling.

This demonstration project has similar disincentives to those found in Demonstration Project Number 1. For example, the type of storage container typically used at construction sites for recyclables (a temporary wire fencing enclosure) was recently prohibited by some of the metro area municipalities due to ongoing concerns with wind blown litter and storage time. Since roll-off boxes must then be used, a flat fee is charged for the roll-off and landfill disposal. This practice has greatly reduced the construction waste directed to SMS&R. Once again, the flat fee creates a disincentive to recycle. Haulers have also reported that customers do not want to pay more for recycling of construction debris.

**Economic Feasibility**

There are many challenges, most of which are economic, to operating a facility such as SMS&R. Unless changes occur, this type of facility may not be able to remain in business for an extended period of time.

**Drywall Economic and Market Feasibility Study**

In a separate study, research revealed that gypsum drywall is the most promising new material to target for recycling in Minnesota. The results of this study are presented in Appendix G.
Minnesota has a unique situation in the generation of its drywall construction debris. Drywall subcontractors are typically required to include the cost of clean-up and disposal of waste drywall when bidding a construction job. This results in drywall waste being collected separately from other construction debris. This is not necessarily a common practice in other states, and creates the opportunity to recover and recycle a clean, source-separated material. Even though it was shown in Demonstration Project Number 1 that gypsum drywall was not beneficial to soils on those particular job sites, it has great potential for use in the agricultural industry.

Gypsum drywall is comprised of the mineral calcium sulfate dihydrate (Ca\(_2\)SO\(_4\)-2H\(_2\)O) with a paper backing. Gypsum is commonly used to provide nutrients for agricultural purposes. It can be both a source of sulfur and/or a source of calcium. If drywall is used to supply gypsum, it must be crushed and screened (as needed) prior to application as an agricultural soil amendment.

Research by URS showed that soils in Minnesota need sulfur as an amendment in the area roughly from Hudson, Wisconsin to St. Cloud, Minnesota. Potato crops especially need sulfur, and gypsum may be a suitable source because it does not raise the pH levels of the soil. The recycling scenario found that it would be economically feasible for a facility to process and distribute gypsum drywall to agricultural amendment retailers. Current and future demand for gypsum, further market development, and analytical testing should continue to be explored.

**Recommendations**

Overall, both demonstration projects showed that there are opportunities for recycling of construction waste in the SWMCB area that are currently underutilized. The following are general recommendations:

**Construction waste reduction** – The flat fee waste disposal is the primary disincentive for builders to minimize waste. If the disposal of construction debris could be regulated as a pay-as-you-throw system, there would be more motivation for builders to reduce the amount of waste generated. Another method of regulating waste reduction would be to specify it in construction contracts. For example, municipalities and school districts could be educated about reducing construction waste when building municipal structures and schools by specifying waste reduction and recycling in the construction contracts.

**Construction waste reuse** – Reuse of construction materials at the job site is not formally practiced. Currently, the only reuse of materials that typically occurs is by employees of the builder or subcontractors. A relatively large amount of materials were available for reuse during Demonstration Project Number 1, which could be reduced if materials were better utilized and managed during the construction phase. Also, a common storage area at the job site could facilitate reuse.

**Construction waste recycling** – Demonstration Project Number 1 showed that on-site grinding and beneficial reuse of wood, brick, shingles, and collection and recycling of cardboard, was economically feasible. The demonstration project successfully diverted almost 50% of the construction waste generated from the landfill, which is significant. Demonstration Project Number 2 revealed the many challenges and barriers to operating a central construction waste
processing facility in Minnesota. This project also identified gypsum drywall as a material that is not currently recycled in Minnesota, but could be a promising new recycling opportunity. Research and calculations showed that it may be economically feasible to process this material and recycle it for use as an agricultural amendment.

**Disposal** – The two demonstration projects indicated that many recyclable materials in the construction waste stream continue to be landfilled. There have not been any strong policy or economic incentives to recycle construction waste in the past. Potential state policy changes that could encourage construction waste recycling include requiring recycling or processing of construction waste before it is disposed, and/or more stringent regulations on landfills that accept construction waste. Imposing more stringent regulations generally raises tipping fees, which creates a more competitive environment for recycling and processing centers.

**Subsidy Programs** – Subsidy programs, such as Carver County’s, offer a financial incentive to recycle construction waste by utilizing a processing facility. This type of program is not widely used at this time and should be encouraged.

**Taxation** – Demonstration Project Number 2 revealed the taxation inequities currently in place in Minnesota. The incoming construction waste is taxed at 60 cents per cubic yard regardless of whether the material is ultimately recycled or landfilled. Then, as is a standard practice for this type of processing, inappropriate wastes, such as packaging and incidental trash, are removed and disposed at an MSW facility. This portion of the incoming construction waste is then effectively taxed a second time at the rate of 17%. Possible options include eliminating this taxing structure for MSW removed from construction waste at processing facilities, or placing taxes on construction waste that isn’t processed.

**Advance Disposal Fees** – An advance disposal fee (ADF) is a tax placed on products at the point of sale or distribution level. The tax raises revenue for the management of the waste produced from the product after use. An ADF could be placed on certain construction products to encourage recycling (e.g. wood and drywall) or proper disposal (e.g. caulking). The tax revenue could be used to facilitate management and recycling programs throughout the state. Collection and recycling programs might be feasible if they could be initiated and subsidized by this tax money. ADFs have been proposed for other products such as single-use disposable packaging products (e.g. cans, bottles, and jars) and disposable food service products. They have also been proposed for electronic waste (E-waste) because recovery, recycling and/or disposal of E-waste can be very costly. Florida experimented with an ADF on disposable food service products to fund recycling programs for a few years, but allowed the ADF to expire. However, Florida has maintained an ADF on tires since 1989. Since unwanted piles of waste tires have been reduced throughout the state, the $1.00 fee to provide for proper management of used tires has been well accepted by the public. All purchasers of construction products with the ADF would carry the economic burden for this policy change.

Another option is to impose a “permit deposit” to encourage the recycling of C&D debris. The City of San Jose, California proposed a permit deposit on advance disposal fees for C&D waste. Applicants for a construction, demolition, or renovation permit (typically a general contractor) must pay a deposit fee based upon the amount of C&D debris that is expected to be generated...
from the project. To obtain a refund, the permittee must provide receipts to the city verifying
that C&D waste produced was recycled at a city-approved facility. The recycling facilities in the
area were evaluated and ranked according to their waste diversion rates from landfills. A smaller
deposit would be returned to the permittee if a facility with a lower diversion rate were used.
The city also provided C&D waste reduction education. In this situation, the economic burden is
placed on the contractors and others who obtain building permits.

Tax Incentives for Recycling – Half of the states in the U.S. provide tax incentives to encourage
recycling (U.S. EPA, 2002). For example, some states do not charge sales tax on equipment
needed for recycling; some provide tax credits for capital investment in recycling facilities; and
some do not charge property tax for buildings and land used for converting waste into new
products. Minnesota offers a sales tax exemption on construction costs for resource recovery
facilities and recycling processing equipment for recycling processors. A rebate of 6.5 or 7
percent of the equipment costs is available (U.S. EPA, 2002). Perhaps these tax incentives could
benefit parties involved in the construction waste recycling process as well as industries that
utilize recovered construction waste materials. This tax incentive could be combined with the
Minnesota tax policy changes discussed above.

Construction Waste Policy Options – A Summary of construction waste policy options that could
encourage the continuation of these demonstration projects, as well as other construction waste
recycling initiatives, is provided in the table below.

<table>
<thead>
<tr>
<th>Policy Option</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Require processing of construction waste before disposal (similar to MA proposed rule)</td>
<td>Mandates recycling</td>
<td>Economic burden on building contractors; No money or incentive for market encouragement</td>
</tr>
<tr>
<td>Advance disposal fee/tax</td>
<td>Provides money to subsidize and encourage markets and recycling</td>
<td>Economic burden does not directly encourage recycling</td>
</tr>
<tr>
<td>Implement extra fees in permits</td>
<td>Encourages recycling through economic burden Provides money to subsidize and encourage markets and recycling</td>
<td>Economic burden is specifically carried by only those that apply for permits</td>
</tr>
<tr>
<td>Subsidy programs</td>
<td>Encourages use of processing facility</td>
<td>Cost to create and administer programs</td>
</tr>
<tr>
<td>Increased regulation of construction and demolition waste landfills</td>
<td>Indirectly would raise tipping fees to encourage recycling</td>
<td>Puts an initial economic burden on the landfill operators; Does not provide money for market incentives</td>
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In summary, the continued operation and the combination of these two demonstration projects
(i.e. on-site grinding of wood, brick, and shingles; recycling of cardboard; and off-site processing
of construction waste and recycling of drywall) could significantly reduce the amount of
construction waste entering landfills in Minnesota and neighboring states.
1.0 Construction Waste Project Introduction and Purpose

URS Corporation (URS) was contracted by the Solid Waste Management Coordinating Board (SWMCB) to research, identify, coordinate and evaluate two construction waste demonstration projects in the Twin Cities Metropolitan Area. The SWMCB, formed in 1990, is a joint powers board comprised of two county commissioners from the counties of Anoka, Carver, Dakota, Hennepin, Ramsey and Washington, in Minnesota (shown below). To enhance intergovernmental coordination, the Board also includes the Director of the Minnesota Office of Environmental Assistance (OEA) and the Minnesota Pollution Control Agency (MPCA) Metro Division Manager as ex-officio members. The mission of the SWMCB is to increase the efficiency and environmental effectiveness of the region's solid waste management system. The demonstration projects focused on increasing source reduction and recycling of construction waste in Minnesota and reducing the volume and toxicity of construction waste landfilled.

This is the second and final document produced for this project and will be referred to as the “final report.” The first document was a memo, referred to as “Memo #1,” and included the background research for this project and Memo #1:

- Identified recycling and waste reduction options for construction waste;
- Examined potential opportunities for construction waste and existing situations;
- Examined existing regulatory framework for construction waste;
- Assessed local markets and feasibility;
- Solicited feedback from government entities and industry, and
- Recommended two construction waste demonstration projects.
Memo #1 is presented as Appendix A.

These two demonstration projects are the focus of this final report. This final report also includes the methods, results, and evaluation of the two projects, as well as recommended actions.

1.1 Background

Concerns over management of construction and demolition (C&D) debris have recently grown nationwide. Landfilling (disposal) is still the primary form of management, and although many C&D waste components are technically recyclable, recycling is not practiced in all areas or for all components. Many states have recently explored C&D waste reduction and recycling to divert this waste stream from landfills. Similar to Minnesota and SWM CB, other states are concerned about the affect of disposal of construction debris has on human health and the environment. Some background on recycling in other states and specific examples of recycling projects were discussed in Memo #1 (Appendix A).

Research has shown that C&D debris is not as inert as once thought, and could potentially affect groundwater in an unlined landfill as well as produce extremely high levels of hydrogen sulfide in gas emissions (Weber et al., 2002, Lee, 2000). Some states are requiring landfills that accept C&D debris to be lined, install groundwater monitoring systems and provide financial assurance (similar to mixed municipal solid waste (MSW) landfills). A recent survey completed by the University of Florida found that 24 states have some type of liner requirement for landfills that accept construction and/or demolition waste (Townsend et al., 2002). Increased regulation of these landfills can cause tipping fees to rise, thereby encouraging recycling. Other state and local governments are encouraging recycling through tax incentives, fees and mandates. Many states’ goals at this time are to divert C&D debris from landfill disposal to the maximum extent possible. Table 1.1 provides information on the status of various other states’ management of construction debris, with special focus on issues discussed in this report: overall incentives for recycling, central processing facilities and on-site grinding projects (Minnesota is included for comparison). This table is not meant to be all-inclusive, but provides information for comparison purposes that could assist in policy and decision-making. Specific state and local agencies should be contacted for the most current and detailed information.

Table 1.1. Summary of Selected Survey Information

<table>
<thead>
<tr>
<th>State/Agency</th>
<th>Description/Comments</th>
</tr>
</thead>
</table>
| U.S. EPA                                   | • Website: [http://www.epa.gov/epaoswer/non-hw/debris/](http://www.epa.gov/epaoswer/non-hw/debris/)  
  • No federal regulations specifically for C&D debris. |
| Minnesota Pollution Control Agency (MPCA)  | • The Minnesota Office of Environmental Assistance (OEA) has a web page with many good suggestions for reducing and recycling of C&D debris. Some of the recommendations from this report are found there as well. [http://www.moea.state.mn.us/greenbuilding/waste.cfm](http://www.moea.state.mn.us/greenbuilding/waste.cfm)  
  • The Minnesota Sustainable Design Guide was developed by Hennepin County, the OEA, and the University of Minnesota Design Institute. It is a tool to learn about sustainability, manage design decisions, and integrate sustainable design features into site and building design. |
### California Integrated Waste Management Board
- There is a Construction and Demolition Debris Recycling Homepage [http://www.ciwmb.ca.gov/ConDemo/](http://www.ciwmb.ca.gov/ConDemo/).
- A searchable C&D recyclers database for those located in CA is linked to the website.
- Results from a 1999 waste characterization study include C&D debris materials.
- There is a webpage of over 35 publications on C&D debris, all available online [http://www.ciwmb.ca.gov/Publications/default.asp?cat=3](http://www.ciwmb.ca.gov/Publications/default.asp?cat=3).
- There is an “R-Team” to provide recycling assistance to businesses that use recycled feedstock in manufacturing.
- Low interest loans are available for businesses starting or expanding recycling operations. No cost classified advertising is also available to help find markets for materials that are traditionally discarded.
- California has conditional regulations such that landfills that accept C&D waste may or may not need to be lined.

### Georgia Department of Natural Resources, Pollution Prevention Assistance Division (P2AD)
- The P2AD offers no cost, non-regulatory, and confidential technical assistance for reducing, reusing and recycling waste.
- Under their commercial, business and institution section they provide assistance with C&D waste. [http://www.ganet.org/dnr/p2ad/const_demo.html](http://www.ganet.org/dnr/p2ad/const_demo.html)
- There are C&D Waste facts for GA (amounts, number of landfills).
- Links include fact sheets and resources.
- Case studies are highlighted including “On-site Separation of Materials and Land Application of Drywall at a Residential Construction Job Site.” [http://www.ganet.org/dnr/p2ad/longleaf.html](http://www.ganet.org/dnr/p2ad/longleaf.html). This project was used as a reference for the SWMCB project.
- GA does not require C&D landfills to be lined and reported a total of 32 in operation in 1999.

### Indiana Department of Environmental Management
- A link is provided to the U.S. EPA C&D Waste website.
- Indiana requires groundwater monitoring and financial assurance for C&D landfills. Also, a minimum 3-foot soil layer between the solid waste and the locally useful aquifer with a hydraulic conductivity of less than $10^{-6}$ cm/sec is required.
- A demonstration project in Indiana served as a reference for Demonstration Project Number1: *On-Site Grinding of Residential Construction Debris: The Indiana Grinder Pilot, 1999* This project was described in Memo Number 1 and used as a reference for the description of Demonstration Project Number 1 provided to the MPCA by SWMCB.

### Massachusetts Department of Environmental Protection
- The DEP does not appear to have any web pages specifically for C&D debris or waste.
- WasteCap of Massachusetts is a statewide, non-profit, public/private partnership that works with the business community to develop and implement cost-effective recycling, buy recycled, reuse, and waste reduction programs.
  (The page is comprehensive and includes links to definitions, regulations, benefits to recycling, tips for recycling, C&D recycling and reuse services, and facts and figures).
- The Massachusetts Department of Environmental Protection (DEP) has proposed banning the disposal of unprocessed C&D debris by the beginning of...
### SECTION ONE

**INTRODUCTION**

<table>
<thead>
<tr>
<th><strong>URS Corporation</strong></th>
<th>December 31, 2002</th>
</tr>
</thead>
</table>

2003. This would mean that materials classified as C&D debris that have not been passed through the necessary steps to be reused, recovered, or recycled may not be put into a Massachusetts landfill. For more information on the DEP Construction and Demolition Debris program contact Jim McQuade at (617) 348-4095.

<table>
<thead>
<tr>
<th><strong>North Carolina Department of Environment and Natural Resources</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• WasteSpec is a 114-page manual that provides architects and engineers with both model specifications and background information addressing waste reduction, reuse, and recycling before and during construction and demolition. WasteSpec was the result of the efforts of the 33 members of the Construction and Demolition Waste Task Force of Triangle J Council of Governments in Research Triangle Park, North Carolina. Triangle J Council of Governments is a regional planning organization composed of the county and local governments within a six-county area. Excerpts of the document are available online, as well as other links: <a href="http://www.tjcog.dst.nc.us/cdwaste.htm#wastespec">http://www.tjcog.dst.nc.us/cdwaste.htm#wastespec</a></td>
<td></td>
</tr>
<tr>
<td>• North Carolina does not require liners for C&amp;D landfills, but the rules do examine the attenuation properties of the underlying soils.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Vermont Agency of Natural Resources (ANR), Dept. of Env. Conservation (DEC), Solid Waste Division</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• A website set-up according to the waste management hierarchy provides resources and encourages recycling <a href="http://www.anr.state.vt.us/dec/wastediv/R3/WReduct.htm">http://www.anr.state.vt.us/dec/wastediv/R3/WReduct.htm</a></td>
<td></td>
</tr>
<tr>
<td>• A construction site reuse and recycling guide provides links to the ANR waste reduction plan, an interactive/searchable database of markets for recycled/recovered construction materials, links to Vermont job-site case studies, and links to other states’ and other sites with resources <a href="http://www.anr.state.vt.us/dec/wastediv/recycling/c&amp;d.htm">http://www.anr.state.vt.us/dec/wastediv/recycling/c&amp;d.htm</a>.</td>
<td></td>
</tr>
<tr>
<td>• Vermont requires landfills that accept C&amp;D waste to be lined.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Wisconsin Department of Natural Resources (WDNR)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• The WDNR has a searchable online Wisconsin Recycling Markets Directory. <a href="http://www.dnr.state.wi.us/markets/matsearch.asp">http://www.dnr.state.wi.us/markets/matsearch.asp</a></td>
<td></td>
</tr>
<tr>
<td>• WasteCap, WI was discussed in Memo#1 and is a non-profit organization that provides waste reduction and recycling assistance through business-to-business peer exchange targeting construction and demolition debris, computers and other electronics. WasteCap has completed several research and demonstration projects regarding C&amp;D debris and provides resources on their website <a href="http://www.wastecapwi.org/">http://www.wastecapwi.org/</a>. A drywall feasibility study is scheduled to commence in February 2003 in Madison, Wisconsin.</td>
<td></td>
</tr>
<tr>
<td>• Wisconsin has conditional requirements for liners for C&amp;D landfills.</td>
<td></td>
</tr>
</tbody>
</table>
2.0 Introduction and Purpose

The purpose of Demonstration Project Number 1 was to explore the technological feasibility, cost effectiveness, environmental soundness, and regulatory issues associated with on-site grinding and the beneficial reuse of construction wastes. Source-separated untreated dimensional lumber, oriented strand board (OSB), plywood, gypsum drywall, shingles, brick, and small quantities of unrecyclable cardboard and paper packaging were evaluated for beneficial reuse on-site. Some of these materials were permitted to be ground and land applied at construction job sites as erosion control and driveway base; however, the properties of soils at the demonstration project sites did not allow the addition of materials as a soil amendment to be considered a beneficial reuse. In addition to evaluating on-site application, construction waste reduction, reuse and recycling options were explored in order to reduce the volume and toxicity of the construction waste stream.

Pulte Homes, the nation’s largest homebuilder, was interested in exploring environmentally sound methods of construction waste management, and agreed to partner on the project. The Bloomfield Hills, Michigan-based company is a publicly-held residential builder present in 44 markets in the United States, Mexico, Argentina and Puerto Rico. Pulte Homes has built more than 407,000 homes and serves all buyer market segments. Most of the homes built by Pulte Homes in the Twin Cities Metropolitan Area are multi-family residences. Pulte Homes utilizes on-site wood framing methods. The original proposed demonstration project locations were the Pioneer Point development in Chaska (Carver County), and the Regatta Development in Apple Valley (Dakota County). However, the approval process with the project partners and MPCA took much longer than anticipated. The Chaska site had already finished construction by the time the application and approvals were completed, so data was collected from another Pulte Homes site, Arboretum Village, located in Chanhassen (Carver County).

On-site grinding of construction materials was also examined at another site by SWMCB in cooperation with Dakota County. The project was at a Hans Hagen (panel-style production builder) site, in the City of Carver (Carver County). This demonstration project was not part of the scope outlined for this report; however, it was conducted in parallel with the URS project and under the same regulatory approval process. Dakota County has documented the Hans Hagen project in a separate report contained in Appendix B. The locations of both the Pulte Homes and Hans Hagen on-site grinding demonstration projects are presented on the map below.
2.1 Scope of Services

The scope of services for Demonstration Project Number 1 was developed based upon the Minnesota waste management hierarchy:

- Reduce/minimize waste generation;
- Reuse materials for their original intended purpose;
- Recycle materials for other use; and
- Dispose of remaining materials.

The scope of services also included partnering in the regulatory approval process, analyzing data collected from the demonstration project, and documenting the evaluation of the project through this report. The approval process for Demonstration Project Number 1 began in January 2002 and ended in July 2002 (a period of seven months). On-site grinding data was collected from the beginning of July 2002 through the end of October 2002 (a period of four months).

2.2 Project Partners/Participants

Besides SWMCB and URS, various other entities participated and played essential roles in this project. This section outlines the primary project partners and provides a brief description of their roles and relationships.

SWMCB Commissioner and Staff
Solid Waste Management Coordinating Board – Commissioner Dennis Hegberg serves as Lead Commissioner, NonMSW Implementation Group.
Richardson Richter & Associates – Jan Lucke served as the SWM CB project manager and assisted in the development of regulatory application documents.

Ramsey County – Michael Reed served as the SWM CB project leader and assisted in the development of regulatory application documents.

Carver County – Brad Hanzel participated on the project team and assisted in coordinating demonstration projects in the cities of Chanhassen and Carver.

Dakota County – Sheila Wiegman participated on the project team as the SWM CB lead staff representative for the NonMSW Implementation Group. Ms. Wiegman conducted air emissions calculations for the grinding equipment and prepared the report on the Hans Hagen demonstration project.

Service Providers
Construction Waste Solutions (CWS) – CWS is a construction waste service company that provides on-site grinding and land application of construction waste materials; collection and recycling of cardboard, metals and other recyclables; and waste removal. CWS conducted the grinding of the construction debris as well as the application of the materials on-site for beneficial reuse. Construction Waste Solutions also collected data and provided it to URS for project evaluation.

Construction Debris Management (CDM) – CDM sells and leases grinding equipment. CDM supplied the grinding equipment to Construction Waste Solutions; provided technical assistance, education and training to Construction Waste Solutions and construction contractors and subcontractors; and served as a liaison between Construction Waste Solutions, Pulte Homes, Hans Hagen Homes, SWM CB, and URS.

Builders
Pulte Homes – Pulte Homes is the residential builder that participated in the SWM CB demonstration project with URS.

Hans Hagen Homes – Hans Hagen Homes is one of two residential builders that participated in on-site grinding and beneficial reuse of construction waste. The Hans Hagen project is documented by Dakota County (Appendix B).

Regulatory Agencies
Minnesota Pollution Control Agency (MPCA) – MPCA provided regulatory oversight and approval for the project.

Minnesota Office of Environmental Assistance (OEA) – OEA assisted the project team in identifying opportunities for on-site beneficial reuse and recycling of construction waste materials.

Carver County Soil and Water Conservation District (SWCD) – SWCD staff provided technical assistance in using shredded wood products for erosion control measures. SWCD monitored
compliance with the builders’ existing National Pollutant Discharge Elimination System (NPDES) permits, and assisted with communication of compliance matters between the state and local units of government.

Academic Institutions
University of Minnesota – Soil scientists provided guidance and expertise relative to the evaluation of soil conditions.

University of Florida – Dr. Tim Townsend and Jenna Jambeck worked as subcontractors of URS to provide technical assistance for data compilation, publication of Memo #1 and the final report.

Contracted Consultant
URS Corporation – Sabina Ylinen was the project manager for the Construction Waste Project.

Contact information for primary project participants is provided in Section 6.

2.3 Regulatory Approval

The main goal of Demonstration Project #1 was to evaluate the actual on-site grinding process; however, it was critical that regulatory approval be obtained from all applicable state and local agencies before it could begin. The approval process for this demonstration project took longer than anticipated, but has provided valuable information that may be used by others in the future. The MPCA verbally approved the project to begin in July 2002. The approval letter and application document are provided in Appendix C. The MPCA approved this project as a demonstration project. There are no rules governing the beneficial reuse of solid waste. The MPCA is in the process of developing such rules, which should be available for public comment in 2003.

A regulatory application document for the demonstration project was prepared by SWMCB with cooperation and input from others, including the partners described in Section 2.2. This document included a description of the project goals, time frame, locations and participant’s roles and responsibilities. It also included a solid waste management plan, a solid waste utilization plan, air quality and public information, as well as any necessary attachments. Critical portions of the project description submitted to the MPCA are included in the text of this report; however, the entire document is contained in Appendix C. The document submitted to the MPCA serves as an example to follow for others interested in receiving approval for a similar process.

As mentioned in Memo #1 and in the background of this document, on-site grinding of construction materials had been demonstrated in other states such as Indiana and Georgia. These projects were used as references and examples to follow for Demonstration Project Number 1. One of the regulatory issues unique to Minnesota was the need for an air quality assessment in order to grind wood and drywall. This evaluation consisted of calculating the potential to emit (PTE) particulate matter of 10 micrometers in diameter or less (PM10). The regulatory threshold of 25 tons per year is the most restrictive regulation for particulate air pollutants regulated by the MPCA. Particulate matter is emitted in the process of grinding drywall and wood waste. Mike Nelson, MPCA Small Business Assistance Program, assisted Sheila Wiegman, Dakota County
Waste Regulation Manager, in calculating PTE for this demonstration project. It was found that
the grinding of gypsum drywall could potentially emit 17.7 tons per year of PM10. It was
determined that the grinding of wood waste could potentially emit 4.45 tons per year of PM10.
Both levels are well below the regulatory threshold of 25 tons per year.

This project proposed not only to grind but also beneficially land apply gypsum drywall. In
order to meet the definition of “beneficial reuse” the addition of gypsum (calcium or sulfur) has
to be needed by the soils. It was determined through soil sampling and analysis that the soils at
the Pulte Homes Construction Sites in Chaska, Chanhassen, and Apple Valley did not need
gypsum (Ca\textsubscript{2}SO\textsubscript{4}-2H\textsubscript{2}O) as an amendment; therefore, it could not be beneficially reused. Soil
sampling results are contained in Appendix C. The Carver site showed some need for gypsum,
but the application rate recommended by the University of Minnesota (150 to 300 pounds per
acre) was well below the 1,000 pounds per acre needed to make it economical for CWS to grind
and land-apply. Much research went into the potential environmental impact of land application
of gypsum drywall at the job site including “type-x” drywall safety and boron issues (boron is
added to drywall for fireproofing). There were no environmental concerns found. In addition,
industry rumors suggested that some drywall currently manufactured in Mexico and imported
into the United States contains asbestos, but research showed this claim to be unsubstantiated.
The information submitted to the MPCA is contained in Appendix C of this report. Further
discussion of gypsum drywall use is also contained in the Dakota County report (Appendix B).
Approval for land application of the gypsum drywall without beneficial reuse was not considered
for this project, but could be possible with the proper permit and oversight by the MPCA and
local regulatory agencies.

2.4 On-Site Grinding Process

2.4.1 Materials

Various construction materials were characterized, discussed and evaluated for beneficial reuse
in Section 4 of Construction Waste Project Memo #1 (Appendix A). The materials identified for
potential on-site beneficial reuse were the following:

- Wood (solid sawn lumber and engineered wood);
- Drywall;
- Asphalt roofing shingles; and
- Concrete and brick.

Any material not listed above was deemed unacceptable for grinding and was disposed by CWS.
Examples of unacceptable materials include: treated lumber, painted lumber, painted wallboard,
moisture resistant wallboard, BiltRite (not evaluated for this project), plastics, vinyl and MSW. It
should be noted that approval was received to grind and beneficially reuse all of the above
materials except for gypsum drywall (see Section 2.3). Cardboard was collected at the job sites
and was delivered to local recycling facilities.
2.4.2 Collection

CWS provided contractors on-site with containers to separate out materials for grinding. Training for site workers was provided during regular construction meetings. Examples of these containers from the Chanhassen site are shown in Figures 2.1. CWS also placed bins to collect cardboard for recycling. Early in the process, they frequently found these containers contaminated with materials inappropriate for recycling, including the plastic and foam shown in Figure 2.2. Contamination issues diminished considerably as the project progressed. Multi-lingual informational stickers placed on containers and a financial penalty program for subcontractors found to contaminate containers helped reduce contamination in the bins. Containers were moved to the central grinding location using a forklift.

![Figure 2.1. Containers for separation of wood for grinding (Chanhassen site).](image1.png)

![Bin placed for recycling of cardboard (Hans Hagen site).](image2.png)

![An example of contamination in recycling bin at Chanhassen site.](image3.png)

![Figure 2.2. Recycling bins at the construction sites.](image4.png)
2.4.3 Equipment

The grinder used for this project was a Packer Industries 750 Mobile Grinder. The grinder weighs 9,600 pounds and general specifications include:

- 123 HP diesel engine;
- Closed loop hydraulic system;
- Direct drive grinder;
- Screen sizes available from 1 to 4 inches (2-inch used);
- Dust suppression system (baghouse and water misting);
- Grinding hopper and chamber are fully enclosed; and
- Magnetic head pulley.

The grinder remained in an easily accessible location at the construction sites rather than being moved from home to home. CWS did report some operational difficulty working with this type of grinder. Down-time ranged from minutes to a day. CWS was able to modify and correct many of the operational issues and productivity then increased. Figure 2.3 is a photograph of the 750 Mobile Grinder.

![Figure 2.3. The 750 Mobile Grinder used for on-site grinding of construction materials.](image)

A surface loader (skid steer) was used to move materials around the site, including those for loading the grinder and application of ground material. An ASV RC50/30 All Surface Loader was chosen for these purposes (Figure 2.4). This equipment was selected for the following reasons: ability to handle all terrain; low ground pressure exertion, resulting in reduced soil disturbance; high ground clearance; and no tires that may puncture.
2.4.4 Grinding

This demonstration project followed the guidelines provided by the National Association of Home Builders, which is provided in Appendix D of the document submitted to the MPCA (Appendix C of this report). Specifications for the materials to be ground are provided below in Table 2.1. Figure 2.5 provides photographs of the actual grinding process as well as the finished product.

<table>
<thead>
<tr>
<th>Material</th>
<th>Use</th>
<th>Grinding Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid sawn and engineered wood products including untreated/ unpainted plywood and oriented strand board (OSB).</td>
<td>• erosion control</td>
<td>Less than one square inch particle size.</td>
</tr>
<tr>
<td></td>
<td>• sediment control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• temporary walkways on job site</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• landscape mulch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• temporary splash protection for finished exteriors (i.e. siding, brick)</td>
<td></td>
</tr>
<tr>
<td>Brick, cement block and landscape pavers</td>
<td>• driveway subbase</td>
<td>Less than one square inch particle size.</td>
</tr>
<tr>
<td>New asphalt shingles</td>
<td>• driveway subbase</td>
<td>Less than one square inch particle size.</td>
</tr>
</tbody>
</table>
2.4.5 Application of Materials

2.4.5.1 Shingle/Stone/Other Aggregate

There are no known risks associated with the on-site use of new shingles, stone and other aggregate as a replacement for Class 5 aggregate for driveway base. As discussed in Memo #1, the Minnesota Department of Transportation currently uses salvaged shingles, stone and other aggregate in a variety of roadway applications (Mn/DOT, 1996).

Ground shingle, stone and other aggregate material can be used as a substitute for Class 5 aggregate for driveway bases, thereby reducing the amount of Class 5 aggregate needed at the construction site. When applied, the ground material was spread 0 to 2 inches thick using an ASV RC50 All Surface Loader. Additional Class 5 aggregate may have been used for a combined base of 3 to 8 inches depending on contractor specifications. All base materials are compacted in place prior to the placement of concrete or asphalt. Figure 2.6 is an example of the aggregate used as driveway base at the Chanhassen site.
2.4.5.2 Wood

There are no known risks associated with the on-site use of untreated, clean solid sawn, dimensional lumber as was done in this project. Although not deemed an environmental risk (NAHB, 1999), engineered lumber may contain the following resins/adhesives:

- Oriented Strandboard (OSB): phenol-formaldehyde resin (PF) or methylenediphenyl diisocyanate (MDI) resin.
- Medium Density Fiberboard (MDF): urea-formaldehyde resin.
- Softwood plywood (typically industrial and construction grade): phenol-formaldehyde resin.

According to the Indiana Grinder Pilot report (NAHB, 1999), the soil testing conducted by the Indiana Department of Environmental Protection (IDEM) detected no elevated levels of heavy metals in soil samples. IDEM also reviewed results from soil testing by the Orange Regional Landfill in Orange County, North Carolina, showing no measurable heavy metals or formaldehyde detected in wood waste piles consisting of C&D wood waste. It was also noted in the report that engineered wood products manufactured with adhesives have an uncertain affect on plant growth.

The MPCA approved land application of engineered wood products for purposes of this demonstration project. Both solid sawn lumber and engineered lumber were ground and used on-site. Engineered lumber constitutes a smaller fraction of the wood waste generated on-site. Specific details of the amount and type of wood used on site are presented later in Section 2.0.
Ground wood (mulch) can be used for erosion control, sediment control, temporary walkways on the job site, landscape mulch, tree root zone protection and as temporary splash protection for finished home exteriors (such as siding and brick). The focus of this project was to evaluate the use of ground wood primarily as erosion control. Secondarily, the ground wood could be used for temporary walkways on the job site and landscape mulch. The primary use of the ground wood mulch was for erosion control along the roads, sidewalks and around the units for the construction workers to walk on. Figure 2.7 shows some of the ground wood application and uses.

Table 2.2. Ground Wood Applications and Specifications.

<table>
<thead>
<tr>
<th>Wood Application (most desired use first)</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion Control</td>
<td>Ground wood spread at a thickness of 0.75 to 2 inches.</td>
</tr>
<tr>
<td>Temporary walkways on the job site</td>
<td>Ground wood applied at a depth of 2 to 6 inches as appropriate.</td>
</tr>
<tr>
<td>Landscape mulch</td>
<td>Ground wood applied at a depth of 2 to 4 inches.</td>
</tr>
</tbody>
</table>

Figure 2.7 Ground wood applications and uses.
Upon construction completion, wood mulch used as erosion control and temporary sidewalks was spread less than 2 inches thick using an ASV RC50 All Surface Loader where conditions of terrain and landscaping considerations permitted. A minimum of 3 inches of topsoil was spread over wood mulch in preparation for landscaping. Figure 2.8 depicts the graded soils (final) on top of the wood mulch after use.

![Figure 2.8. Final grade of soils after use of wood mulch on-site.](image)

### 2.5 Evaluation of Demonstration Project Number One

#### 2.5.1 Construction Waste Generated

As discussed in Memo #1, Pulte Homes generates the following approximate amounts of construction waste for a typical 2,000 square foot home:

<table>
<thead>
<tr>
<th>Waste Material</th>
<th>Quantity Generated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Sawn Lumber</td>
<td>1,600 pounds/0.8 tons</td>
</tr>
<tr>
<td>Engineered Lumber</td>
<td>1,400 pounds/0.7 tons</td>
</tr>
<tr>
<td>Drywall</td>
<td>2,000 pounds/1 ton</td>
</tr>
<tr>
<td>Cardboard</td>
<td>500 pounds/0.25</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,500 pounds or 2.75 tons</strong></td>
</tr>
</tbody>
</table>

The square footage of a Pulte Homes townhome is typically a bit less than 2,000 square feet and an average Pulte Homes townhome generates approximately one and a half 30-cubic yard dumpsters of waste. Before this demonstration project, the entire construction waste stream was disposed at a demolition debris landfill. According to Mr. Kevin Peterson, CDM, Pulte Homes paid approximately $700 per housing unit for disposal of construction waste.

At the Chanahassen site from July 2002 through October 2002, 78 housing units were framed, which equals 3,510 cubic yards of total waste generated during that time period. At the Apple Valley site, a total of 36 units (at 45 cubic yards/each) were framed and 12 units “cleaned” of waste after construction was complete (11.25 cubic yards/each) during the time frame of the project, resulting in an estimated 1,755 cubic yards of construction waste.
2.5.2 Construction Waste Reduction and Recycling

Results are presented based upon the Minnesota waste management hierarchy:
- Reduce/minimize waste generation;
- Reuse materials for their original intended purpose;
- Recycle materials for other use; and
- Dispose of remaining materials.

2.5.2.1 Reducing Waste

Because of the flat fee charged for waste disposal at construction sites, there is no existing financial incentive for the builder to recycle or reduce the amount of waste generated. For example, if two 30 cubic yard waste disposal containers are filled per home, and a flat fee is charged per container, the builder has no incentive not to fill the second container for every house, since they will pay the same rate whether the container is full or not. This flat fee rate actually encourages the customer (i.e. the builder) to fill waste containers. Existing purchasing practices pose another disincentive for waste reduction at the job site. Subcontractors are often provided the materials to do a job from the builder. The subcontractor does not pay for the purchase or disposal of materials, so there is no motivation to reduce or reuse waste. URS recommends a regulated pay-as-you-throw (by volume or by weight) payment option for construction waste disposal to encourage builders to reduce waste. Another option is to assign responsibility to the subcontractors for purchase and/or waste disposal of materials, which may encourage more efficient construction material management.

2.5.2.2 Reuse

A fair amount of material that is still usable and may be reused for its intended purpose is disposed by builders. An informal reuse process was developed by CWS. Materials that were intended for disposal were used by an employee of CWS to construct farm outbuildings. The wood available for reuse (over a four month period from both the Apple Valley and Chanhassen sites) included the following:
- 1x2 (90 boards, 16 feet long);
- 1x4s (2 boards, 8-10 feet long);
- 1x6s (15 boards, 6-10 feet long);
- 2x4s (62 boards, 7-10 feet long and 41 boards, 10-16 feet long);
- 2x6s (93 boards, 7-10 feet long and 18 boards, 10-14 feet long);
- 2x8s (9 boards, 8-12 feet long);
- 2x10s (5 boards, 8-12 feet long);
- 2x12s (3 boards, 8-12 feet long);
- 4’ x 8’ x ¾” flooring wood sheets – 39 sheets; and
- 4’ x 8’ x ½’ roofing particle board – 33 sheets.

In addition, 46, 8-foot long, 2x4 boards were picked up for reuse by a manufacturer from St. Bonifacius, Minnesota. The manufacturer used the wood to construct custom pallets for their product.
URS recommends a common storage area at a construction site for materials that are still usable so that they may be returned for credit or reused for their intended purpose by others. Materials could be donated for reuse, or sold to suppliers or employees, or even the subdivision residents. Used construction materials can be distributed and sold at used construction materials retailers in the Twin Cities Metropolitan Area (for example, there are retailers of materials obtained from systematic deconstruction of buildings). However, if waste is reduced in the first place and materials are properly ordered for the size of the job, there should be less unused material remaining at construction sites.

### 2.5.2.3 Recycling

The materials that were ground and used on-site primarily included solid sawn lumber, engineered wood, and pallets. Some brick and shingles were also ground and recycled. The use of these materials was discussed in previous sections. The amounts of materials recycled are presented below. Data sheets were compiled by CWS as they completed the grinding, recycling and land application work. These data sheets included the quantity ground, staff and time needed, percent ground versus percent landfilled, and description of application or end use. An example of the data sheet is provided in Appendix D.

#### Wood

The labor needed for the solid sawn lumber, engineered lumber and pallets typically consisted of two workers split between the tasks of chainsaw time, grinding and application time. A total of 78 housing units were framed from the beginning of July 2002 through October 2002 at the Chanhassen site. A total of 1,655 cubic yards of wood (both solid sawn lumber and engineered wood) was ground and beneficially used on-site. 100% of the wood collected was ground and recycled. This diverted approximately 47% of the entire waste stream (by volume) from the landfill. Besides the lumber waste, 157 wood pallets were ground and utilized. The average amount of wood per pallet in the U.S. in 2001 was 17.3 board-feet (Pallet Enterprise, 2002). A standard conversion of 5.5 board-feet per cubic foot (SWCF, 2002) results in the volume of wood in a pallet to be 3.15 cubic feet or 0.12 cubic yards. The total volume for 157 pallets ground is 19 cubic yards. Table 2.3 presents the amount of each type of wood ground and recycled as well as the time to process and apply it. The time (ton/hr) was calculated by summing the labor for the chainsaw, grinding and application for the entire wood amount recycled, and dividing by the tonnage. The pallet grinding is much more time and labor intensive per ton than the lumber. This is because pallets must be disassembled and cut with a chainsaw before grinding. There is potential for some pallets to recovered in their existing form and reused.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (cy)</th>
<th>Weight (tons)</th>
<th>Time (ton/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Sawn Lumber</td>
<td>970</td>
<td>146</td>
<td>0.80</td>
</tr>
<tr>
<td>Engineered Wood</td>
<td>685</td>
<td>103</td>
<td>0.78</td>
</tr>
<tr>
<td>Pallets</td>
<td>19</td>
<td>2.85</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*Conversion factor of 300 lbs/cy*
At the Apple Valley site, a total of 36 housing units (at 45 cubic yards/each) were framed and 12 units cleaned (11.25 cubic yards/each) during the time frame of the project, resulting in an estimated 1,755 cubic yards of construction waste. A total of 670 cubic yards of wood (both solid sawn lumber and engineered wood) were ground and beneficially used. 100% of the wood collected was ground and recycled. This diverted 38% of the waste stream (by volume) from the landfill. Another 153 pallets were ground. Table 2.4 contains the data for the Apple Valley site. Conversions and calculations were conducted similar to the Chanhassen site discussed above.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (cy)</th>
<th>Weight† (tons)</th>
<th>Time (ton/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Sawn Lumber</td>
<td>394</td>
<td>59</td>
<td>0.81</td>
</tr>
<tr>
<td>Engineered Wood</td>
<td>276</td>
<td>41</td>
<td>0.74</td>
</tr>
<tr>
<td>Pallets</td>
<td>18</td>
<td>2.7</td>
<td>0.28</td>
</tr>
</tbody>
</table>

†Conversion factor of 300 lbs/cy

The Chanhassen site was inspected by Aaron Mlynek of the Carver County Soil and Water District. He reported that the silt fence/wood mulch combination approach appeared to meet the erosion/sediment control permit requirements. He reported the combination of controls worked well because the mulch provides erosion control and the silt fence provides sedimentation control. Additionally, rock used as driveway base also helped. Mr. Mlynek considered the combination approach of using mulch and silt fencing to be better than using just silt fencing, because there is less failure of the silt fence and less maintenance is required. He did not observe how well the mulch was cleaned up after the fencing was removed.

**Brick**

The volume of brick waste produced for each house is less than wood waste. At the Chanhassen site, 2 cubic yards of brick came from 6 units and was ground for beneficial reuse. Brick can be mixed with other materials and used as a driveway subbase. Labor for this process can be completed by one or two workers grinding and applying the material. Table 2.5 contains the detail for the brick ground and recycled. The time calculation is again a result of the sum of the time for grinding and application divided by the total tonnage.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (cy)</th>
<th>Weight† (tons)</th>
<th>Time (ton/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick</td>
<td>2</td>
<td>1</td>
<td>0.80</td>
</tr>
</tbody>
</table>

†Conversion factor of 500 lbs/cy

**Shingles**

At the Apple Valley site, 2 cubic yards of shingles were ground and beneficially reused. Labor for this process can be completed by one or two workers grinding and applying the material; however, no time period was recorded for the amount of shingles ground and recycled. The application of the recycled materials was for driveway subbase at the site.
A concern with grinding and recycling asphalt shingles is the potential for them to contain asbestos; however, if the shingles to be ground are new, a certificate may be obtained from the manufacturer certifying that the shingles are asbestos-free. In the United States, asbestos has not been used in the manufacturing of asphalt shingles since the 1970s; however, Canadian shingles may still contain asbestos. The Construction Materials Recycling Association (CMRA) and the University of Florida, under a grant from the U.S. EPA, developed a website that provides resources for asphalt shingle recycling. The environmental and permitting page of the website provides state regulatory contacts, an overview of asbestos issues and regulations, and information on the presence of asbestos in asphalt shingles. Because of concerns raised over the presence of asbestos in asphalt shingles, several shingle recyclers have done extensive testing to confirm that asbestos is not a concern. The CMRA has compiled (and continues to compile) a database of test results for asbestos in asphalt shingles. A summary of the test results is available on the website located at www.shinglerecycling.org.

Cardboard

Containers were placed at the demonstration projects for collecting cardboard. CWS reported that the cardboard collection and recycling was initially challenging, but proved to be successful and economical once the subcontractors were trained. The key for this type of recycling is correctly training the subcontractors, while still keeping the process simple. CWS averaged 2.9 tons of cardboard a week from four Pulte Homes job sites and one Hans Hagen site. Cardboard was collected at the job sites and delivered to Rock-Tenn, a local recycling facility.

Other Recycling Opportunities

Other construction materials were examined for recycling; however, separation at the site and storage was a challenge. Markets for items such as vinyl are not developed in the area. Some wood mulch was given to a company that mixes the mulch with seed and compost, then discharges the mixture through a large blower to make berms for sediment control. This company reported that the wood mulch provided by CWS worked well. In the future, if this vendor were brought on-site, the wood mulch could be fed directly into the blower (no transportation costs) and sediment control berms could be produced on-site.

2.5.2.4 Disposal

Residuals that were not reused or recycled were disposed. Local construction and demolition debris landfill tipping fees range from approximately $25 to $35 per ton. Aluminum flashing and soffits were disposed separately by the siding subcontractor. Early in the project, CWS provided disposal service to the sites using 8-cubic yard containers. After a couple of months, CWS and Pulte Homes decided it would be beneficial to use roll-off boxes and have a third party solid waste hauler transport the containers. Both exterior gypsum drywall and treated wood were specifically removed from the waste stream and recorded for data analysis purposes. Interior drywall was recovered and disposed separately by the drywall contractor. Had interior drywall been included in the study, the additional amount of drywall generated would have been approximately one pound per square foot of housing. At the Chanhassen site, (78 units), a total
of 14.25 cubic yards of treated wood and 286 cubic yards of exterior drywall were collected and disposed. The labor for each is contained in Table 2.6.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (cy)</th>
<th>Weight (tons)</th>
<th>Time (ton/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Wood</td>
<td>14.25</td>
<td>2</td>
<td>0.28</td>
</tr>
<tr>
<td>Exterior Drywall</td>
<td>286</td>
<td>71.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

1Conversion factor of 500 lbs/cy

At the Apple Valley site (36 units framed, 12 cleaned), a total of 5.5 cubic yards of treated wood and 112 cubic yards of exterior drywall were disposed. The labor for each is contained in Table 2.7. The raw data showed that the transportation time required for disposal was longer for the Chanhassen site than the Apple Valley site, as indicated in the tables.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (cy)</th>
<th>Weight (tons)</th>
<th>Time (ton/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Wood</td>
<td>5.6</td>
<td>0.84</td>
<td>0.13</td>
</tr>
<tr>
<td>Exterior Drywall</td>
<td>122</td>
<td>30.5</td>
<td>0.97</td>
</tr>
</tbody>
</table>

1Conversion factor of 500 lbs/cy

Treated wood comprised approximately 0.4% of the waste stream while exterior drywall comprised approximately 7.2% (by volume). With a conversion factor of 500 pounds per cubic yard for drywall, over 102 tons of exterior drywall were source-separated and disposed. Treated wood should be disposed in an MSW landfill.

### 2.5.3 Public Notification

This demonstration project required notifying the residents of the properties where on-site grinding was taking place. This notice was prepared by SWMCB and Dakota County and is presented as Appendix E.

### 2.5.4 Economics

In order for waste reduction and recycling to occur, it has to make economic sense. CWS must be able to take the construction waste, process it and beneficially reuse it for the same amount of money (or less) than Pulte Homes would spend and/or save on the disposal of that waste. Most builders will not want to spend more money to recycle waste, even though it is the environmentally responsible thing to do. CWS tracked annual costs for the operation of on-site grinding equipment used. Annual costs are presented in Table 2.8 and details of these costs are contained in Appendix F.
Table 2.8. Annual Operating Costs for CWS

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Purchase</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packer 750 Grinder</td>
<td>$85,000</td>
<td>$22,192</td>
</tr>
<tr>
<td>New Sands Dump Trailer</td>
<td>$6,300</td>
<td>$2,891</td>
</tr>
<tr>
<td>Used 2000 Dodge 1-ton Truck with Dump Body</td>
<td>$21,500</td>
<td>$7,975</td>
</tr>
<tr>
<td>Used 2000 Ford Crew Cab Dual-Wheel 4x4</td>
<td>$25,500</td>
<td>$10,380</td>
</tr>
<tr>
<td>New Skid-Steer Loader ASV RC30</td>
<td>$24,850</td>
<td>$4,927</td>
</tr>
<tr>
<td>New Chainsaws Hasqvarna 136 (2)</td>
<td>$450</td>
<td>$700</td>
</tr>
<tr>
<td>50, 8-cubic yard containers and Hauling</td>
<td>$28,800</td>
<td>$21,955</td>
</tr>
</tbody>
</table>

Pulte Homes was spending approximately $700 per home to dispose of 2.75 tons of waste using two 30-cubic yard roll-off dumpsters. Demonstration Project Number 1 was found to be cost comparable to Pulte Homes previous method of construction waste management, which was use of local landfills. Specific financial information was not available due to proprietary concerns on the part of the on-site contractor, but Table 2.9 provides a general comparison of the previous waste management method and Demonstration Project Number 1.

Table 2.9. Waste Management Comparison

<table>
<thead>
<tr>
<th>Previous Waste Management Method</th>
<th>Demonstration Project Number 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containers: More Than One 30-Cubic Yard Roll-off Dumpsters Per Housing Unit</td>
<td>Containers: One 30-Cubic Yard Roll-off Dumpster Per Housing Unit for Residual Waste Per Housing Unit</td>
</tr>
<tr>
<td>Disposal: All Waste to Landfill</td>
<td>Disposal: Residual Waste Only to Landfill</td>
</tr>
<tr>
<td>Recycling: No Formal Program</td>
<td>Recycling: Cardboard (One 8-Cubic Yard Bin per Four Housing Units, Picked Up Once Per Week)</td>
</tr>
<tr>
<td>Beneficial Reuse: None</td>
<td>Beneficial Reuse: On-site Grinding and Beneficial Reuse of Wood Mulch, Brick and Shingles; Reuse of Wood for Constructing Farm Buildings and Custom Pallets</td>
</tr>
<tr>
<td>Cost: Approximately $700 per Housing Unit</td>
<td>Cost: Approximately $700 per Housing Unit</td>
</tr>
</tbody>
</table>
3.0 Introduction and Purpose

The purpose of this demonstration project was to compliment Demonstration Project Number 1 by continuing to identify benefits and barriers to source reduction and recycling of construction waste and reducing the volume and toxicity of construction waste landfilled in Minnesota.

South Metro Sort and Recycle, Inc. (SMS&R), Shakopee, Minnesota is a construction waste processing facility owned and operated by Dem-Con Companies, LLC, the owners and operators of the adjacent Dem-Con Landfill, an unlined demolition debris disposal facility with very strict waste acceptance requirements. Mr. Jason Haus is Vice President of SMS&R, which began operations in October 1999. Although SMS&R is located in Scott County (Figure 3.1), which is outside of the SWMCB area, it accepts waste from counties located in the SWMCB region, and is an important, although underutilized, component of the construction and demolition debris management system in the Twin Cities Metropolitan Area.

Figure 3.1. Location of South Metro Sort and Recycle.

3.1 Scope of Services

The scope of services for Demonstration Project Number 2 was based upon the following Minnesota waste management hierarchy:

- Reduce/minimize waste generation;
- Reuse materials for their original intended purpose;
- Recycle materials for other use; and
- Dispose of remaining materials.
Although various other states have successful construction and demolition waste processing and recycling facilities, the focus of this study was to examine the existing industry conditions that affect the optimal utilization of the SMS&R facility in Minnesota. SMS&R is a leading materials recovery facility that processes commingled construction waste in the Twin Cities Metropolitan Area.

3.2 SMS&R Operation Description

At SMS&R, construction and demolition waste is unloaded onto the sorting floor and materials with ready markets are separated out by hand and the use of a skid steer. Any remaining material is sent to the adjacent Dem-Con Landfill or an MSW landfill, as appropriate. This is the simplest way of recovering mixed (non-source separated) construction waste. Figure 3.2 depicts the SMS&R facility.

The equipment used at the site includes a cardboard baler, a metal baler, a wood shredder, alligator shears, skid steer, and a front-end loader. On-site personnel typically consists of 4 to 5 employees. SMS&R was able to recycle 35% of the material accepted at the facility (by volume) in 2001. In that year, over 102 tons of metal and 186 tons of cardboard were recycled. This is a significant portion of the waste stream, but additional materials that are recyclable, such as drywall, could be targeted. The examination of SMS&R revealed there are many challenges affecting the success of such a construction waste processing facility in Minnesota. Figure 3.3 presents photos of the operations at SMS&R.
3.3 Permit Conditions

Since the MPCA does not issue permits for the removal of construction debris at a recycling facility, SMS&R holds a demolition/construction waste transfer facility permit. The primary purpose of the facility is to accept unsorted construction and/or demolition waste, sort the materials that may be recycled, and transfer the remaining materials to the landfill. The recyclables are stored on-site until enough accumulate to make it economical to transport and sell them. The facility is permitted to have three operating areas: (1) a solid waste recycling area, (2) solid waste transfer area, and (3) a tire processing area. The following are the maximum permitted throughputs for the facility:

- Municipal solid waste (disposed as residual) – 70 tons/year;
- Demolition/construction debris – 350 tons/day;
- White goods – 40 tons/year;
- Tires – 12 tons/year;
- Recyclables – 8,000 tons/year; and
- Batteries – 1 ton/year.

An annual facility report is required to be submitted to the MPCA. This report includes annual waste activity reports for all three areas of the facility. The facility has an industrial waste management plan, and a contingency action plan (fires/explosion, vandalism) and must adhere to closure and post-closure criteria for such facilities. Closure costs for the facility are estimated at $7,320.

3.4 Evaluation of Demonstration Project Number 2

3.4.1 Existing Challenges/Barriers to Operating SMS&R

The focus of this study was to examine the existing industry conditions that affect the optimal utilization of the SMS&R facility. SMS&R is the only materials recovery facility that processes commingled construction waste in the Twin Cities Metropolitan Area. The examination of
SMS&R revealed there are many challenges affecting the success of such a construction waste processing facility. There have been a limited number of other facilities that have tried to process this waste stream, but have had to change operations due to market conditions. These challenges are outlined and discussed in detail in the following sections.

3.4.1.1 Competition

SMS&R charges a lower tipping fee for source-separated materials and accepts waste on a volume basis because it does not have a weigh scale. This distinction affects the composition of the waste stream that SMS&R receives. Since C&D debris is typically a large volume waste stream, it can be a disincentive to dispose of high volume/low weight material at a facility that charges by volume. SMS&R primarily receives shingles and drywall because these are low volume/high weight materials, which are more cost effective to dispose on a volume basis. Other recyclable materials, such as wood and cardboard, which are low weight/high volume, are commonly brought to other facilities that accept waste by weight; however, these facilities typically do not recycle to the same extent and may simply dispose of the materials. SMS&R has explored the possibility of installing a weigh scale, and has determined that SMS&R would not be competitive with the low per ton tip fee at other facilities.

Hauling and transportation distances, as well as acceptance criteria and competitive pricing at other facilities, has an affect on the amount of waste SMS&R receives. The service area of SMS&R is primarily from the southeastern section of Hennepin County, Carver County, Scott County and some sections of Dakota County. However, even though the hauling distance may be less to SMS&R, some haulers will bypass the facility and go further to another area landfill because of lower tipping fees and more liberal acceptance criteria. In the past 5 years, the amount of waste crossing state lines has increased. This is especially true in southern Minnesota where waste is often transported to Iowa and eastern Minnesota, where waste is frequently transported to Wisconsin. In addition, some haulers own transfer stations and are hauling waste out-of-state because of lower tipping fees. This waste-flow trend includes construction debris being managed as MSW.

Carver County is conducting a pilot program that offers a financial incentive to solid waste haulers who recycle their construction waste rather than landfill it. Licensed haulers may enter into a contract with the county to receive a $2 per cubic yard subsidy for waste delivered to a processing facility such as SMS&R. Six haulers have actively participated in the subsidy program, and as of January 2002, a total of 7,077 cubic yards of construction material was diverted from landfilling.

3.4.1.2 Fees and Taxes

SMS&R has another economic disadvantage. Per Minnesota Statute 297H.04, commercial generators that generate nonmixed municipal solid waste shall pay a solid waste management tax of 60 cents per noncompacted cubic yard. The statutory requirements result in two inequities.

First, all material accepted at a construction and demolition waste processing facility is taxed, regardless of whether the material is ultimately recycled or landfilled. Therefore, there is no tax
incentive to process mixed loads of construction waste for recycling. Minnesota Statute 297H.06 provides for certain tax exemptions to encourage the recycling of MSW. Minnesota Statutes do not provide similar exemptions to encourage the recycling of nonMSW, such as construction waste.

Second, construction and demolition waste is often contaminated with MSW, which is separated and sent to an MSW landfill as residual. The waste is taxed a second time at the rate of 17% (Minnesota Statute 297H.03) upon being disposed as MSW, resulting in a double tax. This places an additional economic burden on SMS&R.

### 3.4.1.3 Disincentives

This demonstration project has similar disincentives to those found in Demonstration Project Number 1. Again, a major disincentive for recycling of construction debris is that a flat rate is charged for disposal of a 30 cubic yard roll-off, regardless how full it is. This actually creates an incentive to be wasteful, since the customer is paying for a fully loaded dumpster despite its actual volume. This is a great disincentive for recycling.

The type of storage container typically used at the construction sites for recyclables (a temporary wire fencing enclosure) was recently prohibited by some of the metro area municipalities due to ongoing concerns with wind blown litter and storage time. Since roll-off boxes must then be used, a flat fee is charged for the roll-off and disposal. This practice has greatly reduced the construction waste directed to SMS&R. The waste stream currently delivered to SMS&R now primarily consists of torn-off shingles and roofing wastes.

The lack of space for additional dumpsters for recyclables is another disincentive for job site recycling. Extra labor is needed for on-site sorting and workers must be trained to sort materials appropriately. Haulers report that customers typically do not want to pay more for recycling of the debris.

### 3.4.2 Markets for End Products

SMS&R reported recycling rates for cardboard and metal in 2001. These were the materials with the two most successful and profitable markets. The ultimate deposition of waste as reported by SMS&R is provided in Table 3.1.

<table>
<thead>
<tr>
<th>Material</th>
<th>Deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals</td>
<td>Scrap Yard</td>
</tr>
<tr>
<td>Cardboard</td>
<td>Paper or shingle manufacturer</td>
</tr>
<tr>
<td>Wood Mulch/</td>
<td>Landscape nursery</td>
</tr>
<tr>
<td>Colored Mulch</td>
<td></td>
</tr>
<tr>
<td>Animal Bedding</td>
<td>Agricultural use</td>
</tr>
<tr>
<td>C&amp;D debris</td>
<td>Dem-Con Landfill</td>
</tr>
<tr>
<td>Residual solid waste</td>
<td>MSW landfill</td>
</tr>
</tbody>
</table>
3.5 Drywall Economic and Market Feasibility Study

As a separate study, research revealed that gypsum drywall is the most promising new material to target for recycling in Minnesota. The results of this study are presented in Appendix G.

3.6 Recommended Actions

There are many challenges, most of which are economic, to operating a facility such as SMS&R. Unless changes occur, this type of facility may not be able to remain in business for an extended period of time. The only way that C&D debris recycling will become successful is if it can make economic sense to the customer, and then in turn, the facility operators. If the recycling could make economic sense to the customer, the facility may become better utilized.

There are a number of ways that SMS&R could become more cost competitive as a result of policy and regulatory changes. In some states, regulations on C&D landfills are becoming more stringent. States are requiring liners, groundwater monitoring and financial assurance in addition to other requirements. This increased regulation causes an increase in capital costs and operating costs which increase tipping fees. This creates a more competitive environment for recycling and processing centers.

The state and/or local agencies could also influence the cost structure of recycling facilities and landfills by taxing non-separated construction debris or offering tax breaks to separated materials and process construction waste residuals that must be disposed at a MSW landfill. Tax incentives could be applied to materials taken to a recycling facility instead of a landfill. It is not always economical for the construction company to source-separate at the site, so a facility like SMS&R is very important if diversion of the construction waste stream from landfills is to be encouraged in Minnesota.
4.0 Conclusions

Two construction waste reduction and recycling demonstration projects were examined for this report. The projects complement each other well because they demonstrate two different management strategies for construction waste. Demonstration Project Number 1 showed that on-site grinding and beneficial reuse of wood, brick and shingles, as well as collection and recycling of cardboard, was economically feasible. The demonstration project successfully diverted almost half of the construction waste generated from the landfill, which is significant. Demonstration Project Number 2 revealed the many challenges and barriers in Minnesota to operating a central processing facility for construction waste.

The on-site grinding and beneficial reuse of certain construction wastes is economical at large construction sites with high volumes of materials. It proved to be an excellent way to divert the largest fraction of the construction waste stream (wood) from landfiling. Mulch from on-site grinding may be supplied to other markets as well. The project was also successful in starting a cardboard recycling program for the production builders.

The central processing facility is important if construction waste is to be diverted from landfills. Many other construction sites may not be able to perform on-site grinding for various reasons, but a central processing/recycling facility is essential to providing an alternate to disposal for waste from construction projects.

The Construction Waste project also identified gypsum drywall as a material that is not currently recycled. Drywall was not shown to be beneficially useful to soils at the production builder's sites, but could be used as an agricultural amendment in Minnesota. The drywall debris is already source-separated at the job site and was shown to be economically feasible to process and distribute (Appendix G).

4.1 Recommendations

Minnesota is currently in a situation similar to many other states. The construction waste stream is being examined by several states to determine management options other than disposal. Information and references provided in the introduction section of this report reveal how some states are trying to reduce construction waste and promote recycling. One key element is education. Many construction companies and workers are unaware of the impact of disposal and don’t realize there are other management options. Many will want to be environmentally responsible; however, are not going to pay more for it. Recycling and reduction of waste needs to make economic sense to them as well. Any thought on policy changes should reflect the fact that recycling must make economic sense to the customer.

Overall, both demonstration projects showed that there are opportunities for recycling of construction waste in the SWMCB area that are currently underutilized.
The following are general recommendations:

Construction waste reduction – The flat fee waste disposal is the primary disincentive for builders to minimize waste. If the disposal of construction debris could be regulated as a pay-as-you-throw system, there would be more motivation for builders to reduce the amount of waste generated. Another method of regulating waste reduction would be to specify it in construction contracts. For example, municipalities and school districts could be educated about reducing construction waste when building municipal structures and schools by specifying waste reduction and recycling in the construction contracts.

Construction waste reuse – Reuse of construction materials at the job site is not formally practiced. Currently, the only reuse of materials that typically occurs is by employees of the builder or subcontractors. A relatively large amount of materials were available for reuse during Demonstration Project Number 1, which could be reduced if materials were better utilized and managed during the construction phase. Also, a common storage area at the job site could facilitate reuse.

Construction waste recycling – Demonstration Project Number 1 showed that on-site grinding and beneficial reuse of wood, brick, shingles, and collection and recycling of cardboard, was economically feasible. The demonstration project successfully diverted almost half of the construction waste generated from the landfill, which is significant. Demonstration Project Number 2 revealed the many challenges and barriers to operating a central construction waste processing facility in Minnesota. This project also identified gypsum drywall as a material that is not currently recycled in Minnesota, but could be a promising new recycling opportunity. Research and calculations showed that it may be economically feasible to process this material and recycle it for use as an agricultural amendment.

Disposal – The two demonstration projects indicated that many recyclable materials in the construction waste stream continue to be landfilled. There have not been any strong policy or economic incentives to recycling construction waste in the past. Potential state policy changes that could encourage construction waste recycling include requiring recycling or processing of construction waste before it is disposed, and/or more stringent regulations on landfills that accept construction waste. Imposing more stringent regulations generally raises tipping fees, which creates a more competitive environment for recycling and processing centers.

Subsidy Programs – Subsidy programs, such as Carver County’s, offer a financial incentive to recycle construction waste by utilizing a processing facility. This type of program is not widely used at this time and should be encouraged.

Taxation – Demonstration Project Number 2 revealed the taxation inequities currently in place in Minnesota. The incoming construction waste is taxed at 60 cents per cubic yard. Then, as is a standard practice for this type of processing, inappropriate wastes, such as packaging and incidental trash, are removed and disposed at an MSW facility. This portion of the incoming construction waste is then effectively taxed a second time at the rate of 17%. Possible options include eliminating this taxing structure for MSW removed from construction waste at processing facilities, or placing taxes on construction waste that isn’t processed.
Advance Disposal Fees - An advance disposal fee (ADF) is a tax placed on products at the point of sale or distribution level. The tax raises revenue for the management of the waste produced from the product after use. An ADF could be placed on certain construction products to encourage recycling (e.g. wood and drywall) or proper disposal (e.g. caulking). The tax revenue could be used to facilitate management and recycling programs throughout the state. Collection and recycling programs might be feasible if they could be initiated and subsidized by this tax money. ADFs have been proposed for other products such as single-use disposable packaging products (e.g. cans, bottles, and jars) and disposable food service products. They have also been proposed for electronic waste (E-waste) because recovery, recycling and/or disposal of E-waste can be very costly. Florida experimented with an ADF on disposable food service products to fund recycling programs for a few years, but allowed the ADF to expire. However, Florida has maintained an ADF on tires since 1989. Since unwanted piles of waste tires have been reduced throughout the state, the $1.00 fee to provide for proper management of used tires has been well accepted by the public. All purchasers of construction products with the ADF would carry the economic burden for this policy change.

Another option is to impose a “permit deposit” to encourage the recycling of C&D debris. The City of San Jose, California proposed a permit deposit on advance disposal fees for C&D waste. Applicants for a construction, demolition, or renovation permit (typically a general contractor) must pay a deposit fee based upon the amount of C&D debris that is expected to be generated from the project. To obtain a refund, the permittee must provide receipts to the city verifying that C&D waste produced was recycled at a city-approved facility. The recycling facilities in the area were evaluated and ranked according to their waste diversion rates from landfills. A smaller deposit would be returned to the permittee if a facility with a lower diversion rate were used. The city also provided C&D waste reduction education. In this situation, the economic burden is placed on the contractors and others who obtain building permits.

Tax Incentives for Recycling - Half of the states in the U.S. provide tax incentives to encourage recycling (U.S. EPA, 2002). For example, some states do not charge sales tax on equipment needed for recycling; some provide tax credits for capital investment in recycling facilities; and some do not charge property tax for buildings and land used for converting waste into new products. Minnesota offers a sales tax exemption on construction costs for resource recovery facilities and recycling processing equipment for recycling processors. A rebate of 6.5 or 7 percent of the equipment costs is available (U.S. EPA, 2002). Perhaps these tax incentives could benefit parties involved in the construction waste recycling process as well as industries that utilize recovered construction waste materials. This tax incentive could be combined with the Minnesota tax policy changes discussed above.
## Summary of Construction Waste Policy Options

<table>
<thead>
<tr>
<th>Policy Option</th>
<th>Pros</th>
<th>Cons</th>
</tr>
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<tbody>
<tr>
<td>Require processing of construction waste before disposal (similar to MA proposed rule)</td>
<td>Mandates recycling</td>
<td>Economic burden on building contractors; No money or incentive for market encouragement</td>
</tr>
<tr>
<td>Advance disposal fee/tax</td>
<td>Provides money to subsidize and encourage markets and recycling</td>
<td>Economic burden does not directly encourage recycling</td>
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<tr>
<td>Implement extra fees in permits</td>
<td>Encourages recycling through economic burden Provides money to subsidize and encourage markets and recycling</td>
<td>Economic burden is specifically carried by only those that apply for permits</td>
</tr>
<tr>
<td>Subsidy programs</td>
<td>Encourages use of processing facility</td>
<td>Cost to create and administer programs</td>
</tr>
<tr>
<td>Increased regulation of construction and demolition waste landfills</td>
<td>Indirectly would raise tipping fees to encourage recycling</td>
<td>Puts an initial economic burden on the landfill operators; Does not provide money for market incentives</td>
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</tbody>
</table>

In summary, the continued operation and the combination of these two demonstration projects (i.e. on-site grinding of wood, brick, and shingles; recycling of cardboard; and off-site processing of construction waste and recycling of drywall) could significantly reduce the amount of construction waste entering landfills in Minnesota and neighboring states.
5.0 REFERENCES


http://www.palletenterprise.com/articledatabase/view.asp?articleID=654

Southern Wood Conversion Factors (SWCF) and Rules of Thumb (2002).


http://www.ees.ufl.edu/homepp/townsend/Research/C&DConv/C&Dconversion.htm


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