

Final Draft Report

**Minnesota Construction, Demolition,
and Industrial Waste Study**

Project No.: 06S015

**Solid Waste Management Coordinating Board
St. Paul, Minnesota**

July 2007



Minnesota Construction, Demolition, and
Industrial Waste Study

Distribution

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Minnesota Construction, Demolition, and Industrial Waste Study

Project No.: 06S015

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July 2007

Minnesota Construction, Demolition, and Industrial Waste Study

Executive Summary

Introduction

The Solid Waste Management Coordinating Board (SWMCB) has evaluated various issues associated with industrial waste and construction & demolition wastes (C&D) since 2004. The goal of this specific study was to provide information for use by the Project Partners and other stakeholders in evaluating construction, demolition, and industrial wastes (CD&I) that can potentially be recovered for reuse, recycling, or creation of energy or compost. The Project Partners included:

- ◆ Minnesota Pollution Control Agency (MPCA)
- ◆ Solid Waste Management Coordinating Board
- ◆ Minnesota Solid Waste Administrators Association (SWAA) working with the Association of Minnesota Counties (AMC)

A project team was formed as a CDI Workgroup that included:

- ◆ Representatives from the MPCA, SWAA, and SWMCB
- ◆ A consulting team including the prime contractor Foth and a subcontractor, Dan Krivit & Associates, Inc. (the Foth Project Team).

Numerous other stakeholders provided input during the data collection and policy development process, including:

- ◆ C&D and industrial waste management industry representatives
- ◆ C&D and industrial waste generators
- ◆ Recyclers and recycling associations

Project Scope

A comprehensive scope of work was developed that included the following components:

- ◆ Literature review on numerous reports, research studies, & articles looking for information on:
 - ▶ Barriers & opportunities
 - ▶ Techniques used elsewhere to promote recovery
 - ▶ Composition information
 - ▶ Processing technologies
 - ▶ Markets

- ◆ Collecting and analyzing Minnesota specific data:
 - ▶ SWMCB and SWAA written surveys
 - ▶ Site visits to industrial and C&D landfills
 - ▶ Transfer station surveys, site visits, and historical delivery data analysis
 - ▶ A C&D waste composition study
 - ▶ Generator site visits and interviews
 - ▶ Survey and discussions with salvage, asphalt, and concrete processors

- ◆ Markets descriptions for:
 - ▶ Asphalt shingles
 - ▶ Metals
 - ▶ Old corrugated cardboard (OCC)
 - ▶ Plastic
 - ▶ Wood
 - ▶ Aggregate
 - ▶ Alternative daily cover (ADC)
 - ▶ Biomass fuel
 - ▶ Wallboard

- ◆ Processing equipment descriptions for mixed C&D processing facilities

- ◆ Demolition site recovery processes and equipment

- ◆ Operating facility data showing potential processing recovery performance

- ◆ Addressing related issues such as:
 - ▶ Projecting available materials and potential recovery
 - ▶ Source separation vs mixed C&D processing
 - ▶ Btu values
 - ▶ Seasonality

- ◆ Summarizing potential barriers and opportunities

- ◆ Identifying potential management approaches

Initial Emphasis on the Data

A series of meetings were held by the CDI Workgroup and with the stakeholders and Waste Stream Policy Committee. The initial emphasis was on the data collection and analysis activity. The second meeting with the stakeholders specifically covered their review and input on the data. The general consensus was that the data presented are accurate. Following is a summary of the key data points of this comprehensive study:

- ◆ To illustrate the relative relationship between MSW, C&D and industrial waste, for 2006 the SWMCB region reported about 1 million tons of MSW from the region that was landfilled, while about 1.2 million tons of C&D and 1.1 million tons of industrial waste were sent to landfills serving the region.

- ◆ The received density of waste averaged 460 pounds per cubic yard (as opposed to previously used 1,111 pounds). This results in a significant reduction of the projected total C&D waste tonnage in the state as 460 pounds is used to convert reported cubic yards of waste delivery quantities to tons rather than 1,111 pounds.
- ◆ The average tip fee at 35 Minnesota C&D landfills is \$7.80 per cy or 32.20 per ton.
- ◆ Nationally a tip fee of \$50.00 per ton appears to be the price that stimulates the industry to take additional action for recovery of materials.
- ◆ The construction and demolition waste sort composition data found in the study is consistent with other data sources in Minnesota and Iowa. The most prevalent materials are wood, roofing, dirt/fines, wallboard, and concrete/brick.
- ◆ Greater Minnesota has 96.4% of the land and 45% of the population which related to CD&I wastes causes:
 - ▶ A lack of economies of scale
 - ▶ Counties to subsidize construction and demolition disposal to avoid illegal dumping
 - ▶ Increased transportation costs to a market or legal disposal site.
- ◆ Contaminated soil disposal comprises 46% to 68% of annual waste volumes in four industrial waste landfills serving the Metro Area. There was not a large percentage of packaging wastes or typical recyclable materials. Some landfills receive a significant amount of glass recycling residuals.
- ◆ C&D transfer stations that recover construction and demolition via “dump and pick” achieve at most 10% +/- recovery with some that recover no materials.
- ◆ Installation of construction and demolition processing equipment allows recovery above 50% in some cases.
- ◆ Recovery of construction and demolition materials above 50% requires outlets for alternative daily cover (ADC) to be used for landfill daily cover.
- ◆ The demolition materials with the greatest potential for recovery include:
 - ▶ Wood made into biomass fuel
 - ▶ Roofing material with a market for shingles
 - ▶ Wallboard (i.e. Sheetrock/Drywall) with adequate markets
- ◆ Nationally, operating facility recovery experience has been reported in excess of 90% (dependent on ability to use C&D “fines” and unprocessables as alternative daily cover material).
- ◆ Additional data analysis is needed on the costs and benefits of the CD&I recycling initiatives selected from the options presented in this report. One of the ancillary issues is the need to calculate using current models the resource conservation benefits of such new CD&I recovery, including energy and green house gas emissions savings.

Barriers or Impediments to Increased Material Recovery

Several potential barriers and/or impediments to increased recovery of materials were noted in the study. These included:

- ◆ Economics – Disposal is cheaper than recovery for several reasons such as labor costs for sorting, capital costs for processing equipment, relatively low cost of disposal, low market values for recovered products, and transportation costs (especially in Greater MN)
- ◆ Lack of Markets – This is particularly true for shingles, biomass fuels, wallboard, and crushed glass. Markets for recycled aggregates could also use attention.
- ◆ Low Volumes – Particularly in Greater MN, the total volumes delivered to a facility are relatively low with low amounts of any one marketable material.
- ◆ Lack of Attention or Focus by State and Counties – Most of previous public policy has focused on MSW rather than C&D and industrial wastes. The focus on recycling and recovery of C&D wastes has been increasing significantly in many locations across the nation.
- ◆ Priorities – Part of the lack of focus on C&D wastes is that C&D and industrial wastes are not as “personal” as MSW and have not drawn as much attention. Decisions have been made based on cost. C&D wastes are more inert (less offensive) than MSW.
- ◆ Awareness – The lower attention and lower priorities results in a lack of awareness of the opportunities that exist. Recycling efforts are not as well documented and there are perceptions of limited markets.

Management Options

Several potential management options were identified in this report. With the increased focus on C&D wastes in other locations across the nation, several state and local governments have implemented programs, created legislation, or provided incentives to businesses in an effort to divert C&D waste from disposal in landfills to secondary markets. Many of these efforts to increase C&D diversion have focused on one of the “Three E’s—Environment, Economics, and Enforcement.” People are motivated to recycle by their environmental ethic (i.e., “recycling is the right thing to do”); by cost savings or cost avoidance (i.e., recycling saves money or is cheaper than other options for disposal); and by requirements to recycle (e.g., mandatory recycling ordinances or material bans).

Conclusions and Recommendations

Based on the data developed and input from stakeholders, there are three key areas for the Waste Streams Policy Committee to address to increase recycling and recovery of C&D materials. These include:

- ◆ Market development
- ◆ Development of generator incentives
- ◆ Stimulation of C&D processors

Development of markets, particularly for shingles, biomass fuel, wallboard, and glass will allow significant increases in recovery of CD&I materials. There is also need to continue to work with Mn/DOT on market development for recycled aggregates. Market development is a critical area.

There is a widely held view by stakeholders that generators should take an active role in increasing recovery rather than requiring disposal facility operators to recover materials. Several of the management options noted in the report can be used as means to create incentives for generators.

To achieve the C&D material recovery requires much more processing capacity than is currently available in Minnesota. Identifying means to stimulate the development of C&D processing capacity is an important government role.

A combination of management options from the educational, economic, and enforcement strategies should be pursued as a comprehensive package. Potential combinations include:

Market Development

- ◆ Generic
 - ▶ Adopt a comprehensive market development plan for C&D materials. This plan should include more details on costs and benefits, including resource conservation benefits (e.g., energy savings, green house gas emissions savings, etc.)
 - ▶ Goals for C&D waste diversion can provide positive signals to the private sector.
 - ▶ Clear priorities will help focus government resources and signal to the private sector the general timing of work on specific commodities listed below.
- ◆ Shingles
 - ▶ Continue and expand County – Mn/DOT-MPCA collaboration towards adoption of a new state materials specification providing for the appropriate use of tear-off recycled asphalt shingles in hot mix asphalt (HMA).
 - ▶ Continue to monitor and support industry developments on other higher value end use applications (e.g., as a fuel supplement in cement kilns, as a boiler fuel supplement, as aggregate for new shingles).
 - ▶ Implement best practices for affirmative state and local government HMA procurement policies to offer incentives and market signals to use tear-off RAS.
 - ▶ Develop a targeted grant and loan program for new business development of tear-off shingle recycling operations.
- ◆ Biomass fuels
 - ▶ Promote combining waste management policy and renewable energy development.
 - ▶ Support development efforts for several biomass facilities under consideration such as for Rock-Tenn and Minnesota Power.

- ◆ Wallboard
 - ▶ Facilitate research efforts for markets such as new wallboard, Portland cement manufacture, soil amendment, and compost amendment.
 - ▶ Consider pilot and demonstration projects.
 - ▶ Consider pursuit of product stewardship approaches for wallboard manufacturers.
- ◆ Glass
 - ▶ MPCA should continue to refine glass marketing policies. For example, how should the State encourage best and highest use; specifications for use as alternative daily cover (ADC) at landfills; need for beneficial use determinations when used as an aggregate supplement; and/or additional leadership needs; etc.
 - ▶ Glass market development efforts need further State and local government assistance.
- ◆ Aggregate
 - ▶ Continue to work with Mn/DOT to improve recycled aggregate specifications.
- ◆ ADC
 - ▶ MPCA should continue to refine a larger, more comprehensive policy on the issue of residuals from mixed C&D recycling use as ADC. All stakeholders should be notified of MPCA's intent for such a policy review.

Generator Incentives

- ◆ Sustainable building guidelines such as LEED™
 - ▶ Standardized materials management definitions and C&D recycling measurement guidelines
 - ▶ New, independent C&D recycling certification programs.
- ◆ Government sponsored technical assistance services
 - ▶ Patterned after much of the reduction/recycling assistance provided for MSW
 - ▶ Promotion of sustainable building guidelines
 - ▶ Promoting deconstruction and pre-demolition practices
 - ▶ Promoting numerous best practices via networking, workshops, and forums for designers, developers, contractors, etc.
- ◆ Develop financial incentives
 - ▶ Dedicate current C&D and industrial waste taxes to promoting material recovery
 - ▶ Expand SCORE grants to explicitly cover C&D related recycling activities, especially investments in the end use and processing infrastructure
 - ▶ Pursue having some municipalities implement tools applicable to their level of government such as:
 - ◆ Building/demolition permit deposits with funds returned for documented recycling and recovery
 - ◆ Ordinances requiring recycling as part of certain size projects (similar to city of Chicago system or some variation)
 - ◆ Promote the results of these “demonstration” projects to other municipalities

- ♦ Affirmative procurement strategies (e.g., purchase of HMA derived from tear-off shingles)
- ♦ Set diversion goals (reduction and recycling) specific for C&D
 - ▶ Document current diversion levels so that goals are set at proper levels and monitored appropriately
 - ▶ Use all the other tools within the options to facilitate reaching the goals

Promotion of C&D Processing

- ♦ Several of the generator incentive concepts above will contribute to the development of C&D processing capacity.
- ♦ Make CAP grants available for C&D processing.
- ♦ Develop other grant and loan programs for targeted market infrastructure development allowing private companies to be directly eligible recipients.
- ♦ Consider a statewide, mandatory C&D processing requirement for projects above a certain size (larger than single-family residential or small commercial). This approach would likely facilitate private companies to invest in facilities to provide the processing service.
- ♦ If voluntary efforts to meet C&D goals are not successful, consider adoption of mandatory goals, especially for materials with well-established markets.

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1 Introduction

The Solid Waste Management Coordinating Board (SWMCB) has been evaluating various issues associated with industrial waste and construction & demolition wastes (C&D) since 2004. The goal of this specific study is to provide information for use by the Project Partners and other stakeholders in evaluating construction, demolition, and industrial wastes CD&I) that can potentially be recovered for reuse, recycling, or creation of energy or compost. The Project Partners include:

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- ◆ Solid Waste Management Coordinating Board
- ◆ Minnesota Solid Waste Administrators Association (SWAA) working with the Association of Minnesota Counties (AMC)

A project team was formed as a CDI Workgroup including:

- ◆ Representatives from the MPCA, SWAA, and SWMCB
- ◆ A consulting team including the prime contractor Foth & Van Dyke, Inc. (subsequently reorganized as Foth Infrastructure & Environment, LLC – “Foth”) and a subcontractor, Dan Krivit & Associates, Inc. (the Foth Project Team).

There are numerous other stakeholders that provided input during the data collection and policy development process, including:

- ◆ C&D and industrial waste management industry representatives
- ◆ C&D and industrial waste generators
- ◆ Recyclers and recycling associations

In response to the detailed Request for Proposals (RFP) issued by the SWMCB, the Foth Project Team developed a detailed Work Plan. This report follows the Work Plan and includes the following:

- ◆ A literature review was conducted on several reports, research studies, and articles related to CD&I. This literature review sought information on barriers and opportunities; techniques used elsewhere to promote increased recovery; composition information on the C&D waste stream; and processing technologies and markets. In addition, the Foth Project Team provided background information on C&D jobsite recycling case studies and several industry associations that have a role in activity associated with this report.
- ◆ The Work Plan included five different approaches to collecting and analyzing data around the State of Minnesota, including:

- ▶ A written survey was developed for C&D waste disposal facilities around the state. In addition, SWAA developed a survey specific to their membership with the results included in this report.
 - ▶ Site visits were made to several industrial waste and C&D disposal facilities around Minnesota where interviews were conducted with facility managers and observations made and photographs taken on the wastes actually delivered to the facilities.
 - ▶ Selected transfer stations were visited or the managers interviewed. SWMCB members compiled delivery data from the transfer stations which along with the transfer station visits/interviews provided insight into existing conditions for C&D waste recovery.
 - ▶ A week-long waste composition study was conducted that provided a detailed breakdown of the percent composition for the typical categories of C&D wastes.
 - ▶ Interviews and/or site visits were made with representatives of two basic C&D waste generator categories—home builders and demolition contractors.
 - ▶ The fifth statewide data collection activity sought and compiled information from salvage, asphalt, and concrete processors in Minnesota.
- ◆ Having adequate markets is critical to increasing material recovery. The Foth Project Team provided descriptions of typical and emerging markets for:
 - ▶ Asphalt shingles
 - ▶ Metals
 - ▶ Old Corrugated Cardboard
 - ▶ Plastic
 - ▶ Wood
 - ▶ Aggregate
 - ▶ Alternative daily cover
 - ▶ Biomass Fuel
 - ◆ In order to recover targeted materials, some type of processing equipment and facility is necessary. The Foth Project Team provided descriptions of typical processing approaches, facilities, and equipment. Operating facility data was collected that shows actual C&D recovery performance.
 - ◆ The Foth Project Team Work Plan also addressed the actual availability of the targeted materials and a general discussion on source separation versus mixed C&D waste processing.
 - ◆ The Work Plan included identifying common barriers that limit recovery of the targeted materials and potential opportunities to increase recovery.

- ◆ Finally, the Work Plan addressed identification and analysis of potential approaches that could be used by the Project Partners and stakeholders to increase recovery of the targeted materials from the CD&I waste streams.

The Work Plan also included conducting three meetings with SWMCB Waste Streams Policy Committee, Project Partners, and stakeholders to discuss the data assembled during the study and to discuss and identify potential approaches that could be used to increase recovery of targeted materials in the CD&I waste streams.

The following seven sections of this report sequentially address the tasks in the Work Plan as described above.

There are numerous appendices provided with this report. Some are exhibits of the questions used during the interviews or surveys. Others are resource documents obtained as part of the data collection process. These may be of value for future implementation activities.

2 Literature Review

A fairly extensive list of existing research and data on the CD&I waste streams was provided to the Foth Project Team. SWMCB provided a “Draft List of CD&I Resources” containing pertinent documents and reports related to the CD&I industry. One of the primary resource documents listed in the Draft List of CD&I Resources was a compilation of various research documents and case study examples of CD&I recovery efforts throughout the United States.

The Foth Project Team also reviewed information from other sources available to the Foth Project Team, including:

- ◆ Industry Associations and contacts.
- ◆ Waste composition data from other clients (e.g., Foth conducted a detailed waste composition project of the C&D waste stream in the Des Moines, Iowa market and has C&D recycling facility operating data on the types and percentages of materials recovered.
- ◆ C&D jobsite recycling case studies gathered by Foth staff over the past 12 years on projects conducted throughout Iowa. Case study data contains information on waste types and volumes of building materials generated during residential and commercial new development and demolition projects.

The Foth Project Team conducted an organized review of the material collected seeking specific information relevant to the Minnesota CD&I Project. During the review process the Foth Project Team sought information related to the following:

- ◆ Barriers and opportunities identified
- ◆ Descriptions of techniques used to promote the recovery of CD&I wastes in other locations
- ◆ Composition data
- ◆ Processing technologies
- ◆ Material markets and potential uses
- ◆ Economics

The Foth Project Team found some existing materials repetitive or not as applicable to Minnesota (e.g., composition data from Florida or California is not representative of CD&I wastes in Minnesota). The results of this task are included in the following text and matrix table (Appendix A) which summarizes which literature sources contain information related to barriers and opportunities, recovery techniques, composition data, processing technologies, material markets, and economics of C&D diversion.

2.1 Barriers and Economics

The barriers to diverting C&D waste from landfills have been well documented. Over the years, solid waste officials have conducted studies to characterize the C&D waste stream and identify key barriers to its recovery. One of the barriers cited throughout the literature review process was the economics involved in collecting, sorting, processing and marketing C&D waste. Economic factors like high labor rates for construction workers, excessive fees and taxes paid by C&D processors, low disposal fees at landfills, and the low market value received for end-use products were all cited as barriers to recovering C&D waste.

State and local governments have implemented programs, passed legislation, or provided financial incentives to create opportunities for the C&D industry to develop an infrastructure to divert materials from landfilling and create secondary markets. Many of these efforts to increase C&D diversion have focused on one of the “Three E’s—Environment, Economics, and Enforcement.”

Key barriers identified and discussed throughout the literature review process included.

- ♦ **High Labor Costs:** In the report, *Building for the Future: Strategies to Reduce Construction and Demolition Waste in Municipal Projects*¹ it was stated, “The high cost of labor relative to materials and disposal” was identified as a “systemic barrier” to managing C&D waste. To contractors it’s more cost effective to dispose of excess materials than to increase labor costs to recycle, since additional laborers have a negative impact on project costs and bottom line profits.

While the high labor costs as a barrier are a common perception, in a study, conducted by the University of Florida Center for Construction and Environment, analyzing the savings of deconstruction versus demolition on six structures, it was concluded that although labor costs were 35% higher for deconstruction, the average net deconstruction costs were approximately 37% (\$3.19 per square foot) lower than the traditional demolition costs shown in Table 2-1². The study showed that when other costs are taken into consideration, in this case avoided disposal costs and the high market value estimated for salvaged lumber, high labor costs should not become a determining factor. Other studies have also shown monetary and environmental benefits of deconstruction³

¹ EPA Waste Wise Update. *Building for the Future: Strategies to Reduce Construction and Demolition Waste in Municipal Projects*. INFORM, Inc. 1998.

² *Non-Hazardous Solid Waste – Task 303: Final Summary Technical Report Practices, Opportunities, and Constraints of Construction and Demolition Debris Disposal, Reuse, and Recycling*, US Army Environmental Center, Prepared by National Defense Center for Environmental Excellence (NDCEE), Submitted by Concurrent Technologies Corporation. August 2003.

³ *Resource Recycling*. September 2006. pp. 20-25.

Table 2-1 Comparison of Demolition and Deconstruction Costs

Costs	Demolition	Deconstruction	Deconstruction Savings	Deconstruction Savings (% of Demolition Costs)
Labor	\$1.74 (33%)	\$3.64 (56%)	– \$1.90	+35%
Disposal	\$2.17 (40%)	\$.097 (15%)	+\$1.20	–22%
Hazardous	\$0.97 (18%)	\$.097 (15%)	\$0.00	0%
Other	\$0.48 (9%)	\$.089 (14%)	–\$0.41	+8%
Total	\$5.36	\$6.47	–\$1.11	+21%
Salvage	\$0.00	\$3.28/\$1.64	+\$3.28/\$1.64	–61% to –31%
Net Costs	\$5.36	\$3.19/\$4.83	+\$2.17/\$0.53	

- ♦ **Excessive fees and taxes:** In reports presented by The National Demolition Association (NDA)⁴ and the URS Corporation⁵ taxes and excessive fees created economic disadvantages for C&D material recovery facilities. The NDA report stated that excessive permit fees on C&D recycling facilities make it “impractical” and “economically unattractive” to build and operate facilities in those states. According to a URS report on construction waste in Minnesota, C&D waste processing facilities are often times “double taxed” on residual wastes sent to MSW landfills.
- ♦ **Low C&D landfill disposal fees:** C&D landfills in most states are not required to provide the same level of environmental protection (i.e., liner and leachate systems) as MSW landfills. Therefore, the cost to dispose of waste in demolition landfills in some areas is relatively low compared to MSW landfills. Again, since most contractors are driven by the bottom line there is no financial incentive to explore other options for managing and disposing of C&D waste.

In a report prepared by the University of Florida Center for Construction and Environment⁶ tipping fees around \$50 per ton is the “turning point” for most contractors to begin to explore alternative waste management options. The report states that in regions where tipping fees have approached the \$50 per ton mark (Table 2-2) contractors, workers, developers and owners are not only more open to waste disposal alternatives, but businesses exist to offer alternatives.

⁴ “National Demolition Association Reports: Demolition Industry Promotes C&D Recycling.” National Demolition Association. January 2004.

⁵ URS Corporation, *Construction Waste Project Report*, Solid Waste Coordinating Board – Minnesota, December 2002, URS Job Project Number: 49970-001.

⁶ Kibert, Charles, and Jennifer C. Languell. “Implementing Deconstruction in Florida: Materials Reuse Issues, Disassembly Techniques, Economics and Policy.” University of Florida Center for Construction and Environment. June 2000. #00-05.

Table 2-2 Regional Landfill Tipping fees⁷

Region	State	Average Tipping Fee
Northeast	Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont	\$67.33
Mid-Atlantic	Delaware, Maryland, New Jersey, Pennsylvania, Virginia, West Virginia	\$55.08
South	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee	\$35.13
Midwest	Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin	\$39.30
West Central	Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming	\$18.26
South Central	Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, Texas	\$23.74
West	California, Idaho, Nevada, Oregon, Washington	\$36.40
National Average		\$38.00

- ♦ **Low material market values:** The perceived “low-value” of building materials salvaged for reuse or recycled into new products creates an additional barrier for processors of C&D waste. The economic structure of the deconstruction and C&D recycling industries requires that recovered materials be sold in order to achieve any level of profitability⁸. In a July 2006 *BioCycle* magazine⁹ article on C&D recycling trends it was stated that the low economic value of many C&D materials was due to their “nature”. According to the article heavy and earthy materials like wood and inerts are typically marketed within 10 to 20 miles of where they are processed. Therefore, regional economies play a big role in determining the value derived for these materials.

2.2 Techniques Used to Promote Recovery

Several state and local governments have implemented programs, created legislation, or provided incentives to businesses in an effort to divert C&D waste from disposal in landfills to secondary markets. Many of these efforts to increase C&D diversion have focused on one of the “Three E’s—Environment, Economics, and Enforcement.” People are motivated to recycle by their environmental ethic (i.e., “recycling is the right thing to do”); by cost savings or cost avoidance (i.e., recycling saves money or is cheaper than other options for disposal); and by requirements to recycle (e.g., mandatory recycling ordinances or material bans).

⁷ “Non-Hazardous Solid Waste – Task 303: Final Summary Technical Report Practices, Opportunities, and Constraints of Construction and Demolition Debris Disposal, Reuse, and Recycling.” US Army Environmental Center, Prepared by National Defense Center for Environmental Excellence (NDCEE), Submitted by Concurrent Technologies Corporation. August 2003.

⁸ Chini, Abdol R. and Stuart F. Breuning. “Deconstruction and Materials Reuse in the United States.” Article for *The Future of Sustainable Construction – 2003*. Published May 14, 2003.

⁹ Goldstein, Nora. “Tracking Trends in C&D Debris Recycling.” *BioCycle*. July 2006.

2.2.1 Environment

Over the past decade the U.S. Green Building Council's building ratings certification program, LEED™ (Leadership in Energy and Environmental Design), has been promoting sustainable building among architects and engineers. One of the criteria components of the LEED™ program involves recycling building waste materials to receive points toward certification of the project. In the January 2007 issue of the *American Recycler*¹⁰, William Turley, Executive Director of the Construction Materials Recycling Association (CMRA), stated that the promotion of LEED™ by solid waste officials is one of the reasons for a 5% to 10 % increase in C&D recycling rates over the past several years. While no data currently exists to prove whether the benefits of green building outweigh the costs, it is apparent that the private sector—primarily building owners, architects and engineers—see an environmental benefit to waste reduction.

In a report titled, *White Paper on Sustainability*, the editors of *Building Design & Construction* magazine produced a detailed table listing state and local green initiative programs throughout the U.S.¹¹ (Appendix B). One of the LEED™ based local programs listed in the table, and later modeled by the city of Oakland, California, was the Minnesota Sustainable Design Guide produced by Hennepin County. The program guide was developed in 1997 to educate professionals and the public on sustainable design. There are several types of incentives described in this appendix.

Recently, the State of Minnesota has developed its own local version of a “green building” program through its *Minnesota Sustainable Building Guidelines* (MSBG) as published by the University of Minnesota's College of Design – Center for Sustainable Building Research (CSBR)¹².

2.2.2 Economics

State and local governments have used economic incentives to motivate C&D waste generators, haulers, and landfill operators to increase waste diversion activity. According to the literature reviewed, the economics of recycling C&D waste versus landfilling is becoming less of a barrier in certain parts of the United States. Over the past 10 to 15 years, local and state recycling mandates, financial incentives, and the closure of landfills (both C&D and MSW) has resulted in longer hauling distances and an increased demand in some C&D materials.¹³ As a result, the cost difference between landfilling and recycling C&D waste is diminishing and creating more opportunities for businesses to venture into recycling.

One EPA report indicates that tipping fees are rising at a rate greater than that of inflation. The report indicates a 7% rate of increase in tipping fees as compared to the general inflation rate that hovers around the 2% range. The tipping fees are rising fastest in the most populated areas - the

¹⁰ Hook, Brian R. “Construction and Demolition Recycling Rates Climb.” *American Recycler* Newspaper. January 2007.

¹¹ *White Paper on Sustainability*, Produced by staff of *Building Design & Construction* Magazine. November 2003. <http://www.usgbc.org/Docs/Resources/BDCWhitePaperR2.pdf>

¹² “Minnesota Sustainable Building Guidelines” (MSBG) Version 2.0. University of Minnesota, College of Design – Center for Sustainable Building Research. Other Co-sponsors include the Minnesota Department of Administration, Minnesota Department of Commerce. September 1, 2006. <http://www.msbg.umn.edu>.

¹³ Goldstein, Nora. “Tracking Trends in C&D Debris Recycling.” *BioCycle*. July 2006.

Northeast, East Coast, and the West Coast. As would be expected, regions with high tipping fees have begun looking for alternatives to traditional waste disposal¹⁴.

2.2.2.1 California

Some local and state C&D recycling ordinances and mandates are pushing the economics of recycling versus disposal toward more diversion type practices by imposing civil penalties, like those imposed by the state of California and the city of Chicago.

In 1989, California mandated 25% diversion by 1995 and 50% diversion by 2000, and gave the California Integrated Waste Management Board (CIWMB) the option to impose administrative civil penalties of up to \$10,000 per day for continued failure by local jurisdictions to comply¹⁵. Because C&D waste is a large part of the total waste stream statewide (22%), diversion of this component has been crucial to achieving the statewide waste reduction goal.

One effective C&D waste diversion approach using economic incentives is the city of San Jose’s Construction & Demolition Diversion Deposit Program¹⁶. To meet their diversion goal, officials there use financial incentives to encourage builders to rethink their waste strategy. In order to obtain a building permit in San Jose, a builder must pay, along with the permit fee, a deposit—the amount of which is determined by the square footage of the building (see Table 2-3). To get this deposit refunded, a builder must show how much C&D debris they were able to divert from the landfill. The refund received corresponds to the percentage of debris diverted.

Table 2-3 City of San Jose’s CDDD Deposit Calculation

Building segment	Deposit per Sq. Ft.	Minimum Valuation	Maximum Sq. Ft. Subject to Deposit
Residential new construction	\$0.20	\$115,000	125,000 detached 100,000 attached
Non-residential new construction	\$0.10	\$135,000	25,000 commercial 75,000 industrial
Residential alternations	\$1.16	\$2,000	None
Non-residential alternations	\$0.35	\$5,000	None
Residential demolition	\$0.35	\$5,000	None
Non-residential demolition	\$0.10	None	None
Roof project with tear-off	\$100 (flat rate)	None	None

¹⁴ Kilbert, Charles and Jennifer C. Languell. *Implementing Deconstruction in Florida: Materials Reuse Issues, Disassembly Techniques, Economics and Policy*, University of Florida Center for Construction and Environment, June 2000, #00-05, <http://www.hinkleycenter.com/publications/byauthor.htm#K>.

¹⁵ “Construction, Renovation, and Demolition Waste Materials: Opportunities for Waste Reduction and Diversion.” Sonnevera International Corporation. Final Report for Environmental Partnerships and Education Branch, Alberta, CA. April 2006. page 36.

¹⁶ City of San Jose, California. Construction and Demolition Diversion Deposit program. <http://www.sjrecycles.org/business/cddd.htm>

Other jurisdictions in California have also used economic incentives to encourage C&D diversion. In 2005, the city of San Diego created a differential tipping fee for source-separated loads of C&D waste received at the Miramar Landfill to encourage the recovery of more materials from the C&D waste stream. As shown in Table 2-4, fees ranged from \$43 per ton for mixed C&D to \$10 per ton for source separated loads of concrete.

Table 2-4 Tipping Fees Cost Comparison at Miramar Landfill¹⁷

Material Type	Fees
Mixed Waste	\$43/ton (average) – includes \$24/ton tipping fee, \$12/ton franchise fee, \$7/ton Assembly Bill 939 fee.
Recyclable Concrete	\$10/ton (average)
Recyclable Green Waste	\$22/ton (average)

2.2.2.2 Chicago

In 2004, the city of Chicago passed an ordinance requiring recycling at nearly all construction and demolition projects. In response, a few mixed C&D recycling centers have sprung up in and around the city to help contractors meet those mandates. Under Chicago’s fine based system, contractors are required to recycle 25% (by weight) of all C&D materials by January 1, 2006. By January 1, 2007, the C&D recycling rate increased to 50%. The following types of projects are subject to the ordinance requirements:

- ◆ Construction of new residential buildings with four or more units.
- ◆ Construction of new non-residential buildings over 4,000 square feet.
- ◆ Any rehabilitation of a building that will require a certificate of occupancy to be issued from the Department of Buildings.
- ◆ Demolition of a residential building with four or more units that includes the demolition of at least one outside wall.
- ◆ Demolition of non-residential buildings over 4,000 square feet.

Projects are exempt from the ordinance if only a plumbing, electrical, or mechanical permit is required.

Table 2-5 explains how fines are levied for non-compliance in the Chicago C&D recycling program. Contractors are fined based on the number of percentage points they are below the mandated recycling rate.

¹⁷ Table excerpted from “Construction, Renovation and Demolition Waste Materials: Opportunities for Waste Reduction and Diversion.” Sonnevera International Corporation. Final Report for Environmental Partnerships and Education Branch, Alberta, CA. April 2006. pg. 36.

Table 2-5 Chicago C&D Project Recycling Rate Fine Assessment Level

C&D Project Type	Fine Assessment
For construction projects or demolitions involving 10,000 square feet or more of renovated, newly constructed, or demolished space.	\$1,000 for each percentage point of difference between the amount required by this section to be recycled or reused and the amount actually recycled or reused.
For construction projects or demolitions involving less than 10,000 square feet of renovated, newly constructed, or demolished space.	\$500 for each percentage point of difference between the amount required by this section to be recycled or reused and the amount actually recycled or reused.

2.2.3 Enforcement

Currently, California and Massachusetts are the only two states with legislation and regulations mandating the recycling of C&D wastes. The mandates implemented in California and Massachusetts have had an impact on how C&D wastes are managed in each state and has created opportunities to increase C&D diversion. In California, the State Legislature mandated a 50% waste diversion goal. In order to meet this goal, the CIWMB focused on C&D as a major initiative toward meeting the mandated goal. In 2004, CIWMB developed a model ordinance for local jurisdictions to adopt and implement a C&D program that would require anywhere from 50% to 75% diversion. A copy of this model ordinance is provided in Appendix C. Jurisdictions risk a \$10,000 per day fine if the state’s diversion requirements are not met, either by reaching 50% overall diversion by weight, or by implementing sufficient programs toward reaching this goal to show a “good faith” effort.¹⁸ Mixed C&D recycling facilities in the state are routinely recovering 60 to 90% of all the materials brought to them¹⁹. The CIWMB provides jurisdictions with education, training, and technical assistance tools to assist them in meeting their planned diversion goals.

In 2005, the Massachusetts Department of Environmental Protection (MassDEP) banned specific C&D materials (asphalt pavement, brick, concrete, metal, OCC, and wood) from disposal, transfer for disposal, or contracting for disposal at solid waste facilities in Massachusetts. A C&D subcommittee was formed to assist in developing a ban that would be acceptable throughout the industry and easy to implement. Stakeholders included regulators, haulers, recyclers, environmental groups, architects/engineers, contractors, landfill owners, and transfer station owners, trade associations, building owners, consultants, law firms and municipalities. Solid waste facilities are required to submit a waste ban compliance plan to their regional MassDEP office for review and approval. Development of the disposal ban has provided increased opportunities for in-state processing businesses. According to a DEP spokesperson, the C&D reuse and recycling market infrastructure in Massachusetts will be further enhanced as these banned materials are diverted from disposal²⁰.

¹⁸ “C&D Ordinance and Program Options.” Lisa Keating, Senior Consultant. Hilton, Farnkopf & Hobson, LLC. Newport Beach, CA.

¹⁹ “C&D Recycling Plans and Policies: A Model for Local Government recycling and Waste reduction.” Prepared by Gary Liss & Associates for the University of California Santa Cruz. Publication # 310-01-014. January 2002.

²⁰ “Mass. Ban on C&D Material to be Implemented.” *Construction and Demolition Recycling*. November/December 2005.

MassDEP officials anticipate future benefits from the ban will result in:

- ◆ Massachusetts moving closer to reaching the 2010 goal of reducing non-municipal solid waste by 88%.
- ◆ Increased processing capacity throughout the state for C&D materials.
- ◆ Additional state funding opportunities for establishment of C&D recycling businesses.
- ◆ Development of additional market opportunities for products produced from processed C&D waste material.
- ◆ Development of higher-value reuse markets for materials like salvaged wood.

Some of the issues surrounding the ban included exemptions for rail-haul companies, available markets for banned materials, and enforcement of the ban on all parties. A further discussion of the issues is provided below.

- ◆ In Massachusetts, waste transfer facilities with rail-haul capabilities are not exempt from the ban, but are seeking exemption from the Surface Transportation Board (STB). As a federal agency responsible for railroad transportation in the United States, STB has the power to exempt railroad companies from complying with any federal, state or local laws. The DEP has largely decided that all waste handling facilities will be subject to the ban once it is effective.
- ◆ The timing of the ban and development of markets for some materials was a concern for C&D processors. One concern was that markets for all the banned materials, in particular wood, were not well developed and time would be needed, prior to implementation of the ban, to establish a sufficient market for the material.
- ◆ The ban will impact C&D processors trying to locate reliable markets for C&D fines, which makes-up 40% of some operations end product material. Historically, the market for C&D fines in the Northeast has been use as alternative daily cover (ADC) material at landfills. Recent issues involving the production of hydrogen sulfide gas, in ADC containing gypsum from waste wallboard²¹, has prompted many landfills to discontinue using ADC. As a result C&D processors are losing a market outlet for C&D fines. As a condition of a processor's C&D Fines Beneficial Use Determination Permit, C&D processors must remove gypsum wallboard prior to any processing of C&D debris for ADC. Wallboard was not included in the ban by MassDEP because a reliable market for the material does not exist. C&D processors argue banning wallboard from disposal would create market opportunities and demand for products made from recycled gypsum wallboard.

²¹ "Wallboard" is a generic term that encompasses Drywall and Sheetrock products.

- ◆ To be effective the C&D ban must be enforced at the generator level, as well as at solid waste facilities, to effectively prevent illegal disposal and dumping of C&D materials like asphalt, brick and concrete.
- ◆ In addition, there is the potential issue of C&D wastes being transported out of Massachusetts to landfills in other states for disposal, thereby avoiding the ban. To reduce this potential, the DEP drafted the ban so that it would not conflict with the Commerce Clause.

2.3 Composition of C&D Waste Stream

In Minnesota, statewide composition data currently does not exist for C&D waste. One of the primary reasons lies in Minnesota's definition of MSW and non-MSW. C&D debris is defined as non-MSW and therefore does not receive the same level of attention in the Minnesota Waste Management Act as waste defined as MSW. Historically, funding for solid waste programs, research initiatives, composition studies, and market development efforts have focused primarily on MSW and have resulted in a mature, integrated municipal solid waste infrastructure in Minnesota. At the county level, some composition data has been gathered on C&D wastes generated within the SWMCB region. In a 2002 SWMCB report, *Construction Waste Project*²², it was noted that several composition studies have been conducted at landfills and disposal sites located throughout the Twin Cities metropolitan area (metro area). A 2004 non-MSW waste characterization study²³, led by SWMCB's Non-MSW Data Analysis Work Group, quantified and analyzed existing data on non-MSW materials and categorized them based on toxicity reduction, waste reduction, reuse, and recycling. Composition data on specific C&D waste stream component materials was not presented in the report.

On a national level, the U.S. EPA issued a report in 1998 titled, *Characterization of Building-Related Construction and Demolition Debris in the United States*²⁴, which characterized the quantity and composition of building related C&D waste generated throughout the U.S. The results of the national study may not be representative of the composition of C&D waste in Minnesota, but Table 2-6 provides comparative data from C&D composition studies conducted in Iowa (Des Moines Metro), Florida, and California.

2.3.1 Minnesota

According to SWMCB's 2002 report on construction waste, C&D waste composition studies have been conducted at targeted disposal facilities located within the Twin Cities metro area. One of the waste composition studies was conducted in 1992 at two demolition debris landfills (SKB Rich Valley Demolition Landfill, Inver Grove Heights, MN and Dem-Con Landfill, Jordan, MN) to determine the composition of the incoming C&D waste streams. Details of the study can be found in a document produced in 1993 by the Minnesota Pollution Control Agency

²² "Construction Waste Project Report." Prepared by URS Corporation for Minnesota Solid Waste Coordinating Board. URS Job Project Number: 49970-001. December 2002.

²³ "2004 Characterization of Non-MSW Municipal Solid Waste Stream – Final Report." prepared by URS Corporation, prepared for Minnesota Solid Waste Coordinating Board. August 2004.

²⁴ "Characterization of Building-Related Construction and Demolition Debris in the United States." USEPA. Franklin & Associates. June, 1998.

and titled, “*Measure Twice, Cut Once.*” Results of the composition data collected over a five-day period from each landfill is presented in Table 2-6. Wood, concrete & block, and roofing were the most predominant—making up from 70 to 85% of the composition.

Throughout 1999 and 2000, SWMCB conducted C&D waste composition studies at seven C&D disposal sites (SKB Transfer Station, SKB Rich Valley Demolition Landfill, Veit Transfer Station, Dem-Con Landfill, Recyco Landfill, Elk River C&D Landfill and Burnsville Sanitary Landfill). The survey method consisted of visual observations (rather than weighing samples) being made on a total of 539 loads of C&D waste received between all the facilities. Results of this SWMCB C&D waste composition survey are presented below (Table 2-6). C&D waste stream components that were most frequently observed are shown in the table along with their volume percentage. Wood, roofing, and other were the top three categories.

Table 2-6 C&D Waste Composition Data from Studies Conducted in Minnesota, Iowa, Florida, and California

C&D Waste Stream Components	Percentage				
	Minnesota (1992)	Minnesota (2000)	Des Moines, IA (2002)	Florida (2002)	California (2005)
Wood	40-45%	33%	28%	15%	15%
Concrete & Block (Brick)	15-20%	5%	7%	32%	17%
Roofing	15-20%	20%	21%	6%	15%
OCC/Paper	---	5%	6%	---	3%
Drywall	5-7%	6%	13%	12%	8%
Dirt, Gravel, Rock	2-7%	---	8%	---	8%
Rubber	2-6%	---	---	---	---
Metal	2-5%	7%	5%	5%	4%
Plastic	---	3%	5%	---	<1%
Asphalt	1-2%	---	---	---	10%
Insulation	1-2%	4%	---	---	<1%
Other	1-5%	17%	10%	30%	8%

2.3.2 Iowa²⁵

In 2002, Foth conducted a thorough analysis of waste delivered to Metro Waste Authority’s (MWA) Metro Park East Landfill. The weight-based composition analysis was performed on MSW and C&D waste deliveries to the landfill located in Des Moines, Iowa. Representative loads of residential, commercial and C&D wastes were sampled for a one-week period during the spring and fall seasons. C&D waste comprised 28% (approximately 144,000 tons per year) of the total waste deliveries to the Metro Park East Landfill and contained the highest percentage of potentially recoverable materials for processing into end-use products. Some of those materials accounted for over 113,000 tons per year and included roofing shingles (30,476 tpy),

²⁵ “Final Report - 2002 Waste Composition Analysis: Metro Park East Landfill.” Metro Waste Authority, Des Moines, Iowa. Prepared by Foth Infrastructure & Environment, LLC.

corrugated cardboard (7,859 tpy), metals (6,599 tpy), wood (40,259 tpy), concrete (10,076 tpy), and sheetrock/drywall (18,198 tpy). Wood, roofing, and drywall were the top three categories.

Two privately owned C&D waste processing facilities have been processing approximately 100,000 tons of mixed C&D debris generated throughout the Des Moines metro area since 2004. Operating experience from these C&D processing facilities is described in Section 5.1.4 of this report.

2.3.3 Florida²⁶

The Florida Center for Solid and Hazardous Waste Management conducted a study on the composition of Florida's C&D waste stream in 2002. One of the methods used in the study was visual characterization. C&D loads from seven different C&D debris landfills and recycling facilities were hand sorted and a weight conversion factor was used to determine the weight composition for all loads evaluated. An average composition (by weight) was calculated and the results are shown in Table 2-6.

Wood (20%), concrete (13%), and cardboard (12%) were the most prevalent materials observed from studies conducted at all seven landfills, accounting for 45% of the total waste stream ("Other" was 30%). The study also looked at what C&D activity (source) generated the waste material and found that more wood and drywall waste was generated from renovation than construction. The compositions of demolition debris and renovation waste were found to be similar in make up.

2.3.4 California²⁷

In 2004, the California Integrated Waste Management Board (CIWMB) studied the C&D waste stream, along with three other waste streams, to obtain an estimate of the quantity and composition of C&D waste landfilled in California. Over 600 loads of C&D waste were sampled from four different metropolitan areas (San Diego, Southern California/Los Angeles Basin, San Francisco Bay area, and the Central Valley) during two construction seasons, December (2004) and June (2005). A total of four sampling days were held in each area, two days per season, and the study group divided C&D waste into seven different subsectors (new residential construction, new non-residential construction, residential remodel, non-residential remodel, demolition, roofing, and other) and 86 material types. C&D loads were characterized using a volume-based visual estimating method. Composition results were based on the "divertability" of a particular material type. The divertability factor was determined by the availability of recycling technology, to process material, and market outlets in a particular region of the state.

The study showed that nearly 75% of the C&D waste deemed divertable by researchers and was also estimated to be recoverable. Recyclable aggregates (concrete with and without rebar and other aggregates) composed as much as 27% of the recoverable fraction, while other recoverable

²⁶ "Generation and Composition of Construction and Demolition Waste in Florida." Florida Center for Solid and Hazardous Waste Management. Gainesville, Florida. December 2002.

²⁷ "Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste." produced by Cascadia Consulting Group for California Integrated Waste Management Board. June 2006.

materials (cardboard, composition roofing, and compostable materials) made up 20%, and recyclable wood accounted for approximately 15%.

A review of the data presented in the table above shows the high degree of variability that exists within the C&D waste stream from one geographic area to another. Much of this variability is due to data collection methods, differences in building practices, seasonality of C&D industry across the country, local economic factors, and other variables. For example, the 2000 Minnesota and 2002 Iowa composition data was very similar and may be due to their similarities in climate, geography, and economy, while the results from studies conducted in Florida and California are different in most categories observed. Even so, predominant categories typically include wood; concrete, block, and asphalt; roofing; and drywall.

2.4 Processing Technologies and Markets

The literature review contained some information related to processing technologies and markets. These subjects are covered in more detail in Sections 4 and 5 of this report, which are dedicated to markets and processing technologies.

Multiple studies and reports have been completed on the topic of shingles recycling, many from Minnesota research and development projects. Both the SWMCB and MPCA (formerly the OEA) have funded multiple projects on shingles recycling to further develop both the processing technologies and end markets. Mn/DOT has directly sponsored or participating in many materials research projects to examine the pavement performance properties when hot mix asphalt (HMA) is supplemented with recycled asphalt shingles (RAS). Historically, the research emphasis was on the use of manufacturers' shingle scrap in HMA. Currently, a key priority for these various agencies is on the barriers and opportunities for use of tear-off shingle scrap. See Section 4.1 for more detailed discussion of current efforts on shingles recycling in Minnesota.

2.5 C&D Jobsite Recycling Case Studies

After publication of the 1998 US EPA report, *Characterization of Building-Related Construction and Demolition Debris in the United States*, many state and local solid waste officials began to focus on how building-related waste materials were being managed. In the report, Franklin Associates estimated that nearly 136 million tons of building-related C&D debris was generated in the United States in 1996. Debris from demolition projects accounted for the largest portion (48%, or 64,800 tons) of building-related waste material, while renovation and construction projects accounted for 44% (59,900 tons) and 8% (10,830 tons).

According to the report, landfilling was the most common waste management practice for handling C&D materials. As shown in Table 2-7 below, it was estimated that 35% to 45% of the waste generated in 1996 was managed in C&D landfills, 20% to 30% was recovered for recycling, and 30% to 40% disposed of in MSW landfills and other disposal sites, such as unpermitted landfills or combustion facilities²⁸.

²⁸ "Characterization of Building-Related Construction and Demolition Debris in the United States." USEPA. Franklin & Associates. June, 1998.

Table 2-7 Estimated Management of U.S. Building-Related C&D Debris, 1996²⁹

Management Option	Million Tons/Year	% of Total
Recovered for recycling	25 – 40	20 – 30
C&D landfills	45 – 60	35 – 45
MSW landfills and other ¹	40 – 55	30 – 40
Total	136	100

¹ Includes combustion and disposal in unpermitted sites.

As noted earlier in Section 2.3, since the EPA report, several states have conducted their own C&D waste characterization studies to gather more representative data on building-related waste materials landfilled. At the local level, solid waste officials also began to investigate how C&D waste was being managed at the point-of-generation or on job-sites. From these studies, state and local solid waste officials began to understand the role recycling building-related C&D debris played in meeting state-mandated diversion goals.

In 2001, the Dubuque Metropolitan Area Solid Waste Agency (Agency) failed to meet Iowa’s mandated 25% waste minimization standard, due primarily to a large increase in C&D materials landfilled, more than any other component of the waste stream delivered to the Agency’s landfill in recent years. That failure triggered the subsequent state-mandated tonnage tax increase and implementation of a unit-based pricing refuse collection system.

Over a five year period, from 2002 to 2006, the Agency conducted job-site case studies on construction, demolition, deconstruction, and renovation (CDDR) projects to determine if a local infrastructure existed to support a program targeting C&D waste. The Agency worked with local developers, contractors, architects, public officials, waste collection and recycling companies, and a C&D recycling consultant to gather data on residential and commercial CDDR projects. A C&D recycling consultant was hired by the Agency to develop diversion programs for each project, prepare project waste specification documents, collect and analyze project results.

Table 2-8 lists 14 case study projects conducted with four public and private organizations and businesses. Over the five-year period of conducting these case studies, a total of 15,453 tons of building-related C&D materials had been diverted from disposal in a MSW landfill. While recycling C&D materials was not the norm in Dubuque, case study results showed that that salvage, reuse, and recycling were viable alternatives to landfilling project waste and debris materials, and can be accomplished within the constraints of a typical construction or demolition project. At some sites, demolition debris diversion of over 90% and construction waste diversion of over 50% were achieved through alternative waste management practices like salvage for reuse or resale, recycling, and other diversion methods. These waste reduction levels were achieved at lower costs than if all materials were disposed in a landfill.

²⁹ Ibid.

Table 2-8 Dubuque Metropolitan Area Solid Waste Agency
CDDR Waste Management Case Study Project Results (2002-2006)

Project Participant	Project Name	Project Type	Tons Diverted	% of Total
Dubuque Historical Society (Private, non-profit)	National Mississippi River Museum & Aquarium and Old Depot	Commercial Renovation & Deconstruction	247	51%
Hy-Vee Food Stores (Private business)	Locust Street Hy-Vee Store	Commercial Deconstruction	6,756	98%
City of Dubuque Housing & Community Development Department (Public agency)	Bee Branch Creek Residence (775 Gillespie)	Residential Deconstruction	309	94%
	Bee Branch Creek Residence (805 W. 32 nd St.)	Residential Deconstruction	123	80%
	Bee Branch Creek Residence (815 W. 32 nd St.)	Residential Deconstruction	81	81%
	Bee Branch Creek Residence (895 W. 32 nd St.)	Residential Deconstruction	88	90%
	Bee Branch Creek Residence (503 Rhomberg)	Residential Deconstruction	138	92%
	Bee Branch Creek Residence (695 W. 32 nd St.)	Residential Deconstruction	255	94%
	Bee Branch Creek Residence (685 W. 32 nd St.)	Residential Deconstruction	217	93%
	Bee Branch Creek Residence (645 W. 32 nd St.)	Residential Deconstruction	78	98%
	Dubuque Community School District (Public institution)	Downtown Elementary School – Phase I	Commercial Demolition	3,117
Downtown Elementary School – Phase II		Commercial Demolition	3,200	74%
Downtown Elementary School – Phase IIIA		Construction	131	71%
Roosevelt MS		Construction & Deconstruction	712	76%
Total C&D Tons Diverted from Dubuque Metro Landfill			15,453	

As a follow-up to the case studies, and the positive results achieved, the Agency implemented a Green Vision Building Materials Management and Waste Minimization Program in 2007. The program assists construction and demolition professionals that want to establish reuse and recycling programs at project sites. A Best Management Practices (BMP) Program guide (Appendix D) provides building industry professionals, such as architects, contractors, renovators, and owners with guidelines, procedures, market outlets, and worksheets for establishing reuse and recycling programs at job-sites in Agency planning areas.

Results for each of the 14 case study projects can be found in Appendix D.

2.6 Industry Association Contacts

Numerous industry trade associations, non-profit organizations and other government agencies were contacted as part of this *Minnesota CD&I Study* project. These organizations have directly relevant information or other resources relevant to this project. Appendix E lists all the private organizations contacted as part of this project and some additional ones. Each organization has a web page and many have online relevant publications that can be downloaded. A handful of the industry trade associations were interviewed and/or helped with the respective surveys including: ARM of Minnesota; AGC of Minnesota; BAM; CMRA; MAPA; and NCDA. Several other non-profit and government organizations were also contacted, including The Green Institute; NIST; and USGBC.

In addition, the Solid Waste Administrators Association (SWAA) conducted a written survey of their membership. (See Section 3.1.2 – “SWAA Survey” for more details.).

The information provided by these other associations and organizations was helpful in terms of documenting the current status of CD&I policy, market and technology development activities around the country and here in Minnesota. The breadth of the scope of this study is well represented by the rich diversity of these and other interest groups. Comments or notations from these organizations are included throughout the report.

3 Statewide Data

One of the primary goals of this study was to collect more information regarding the composition and characterization of C&D wastes as well as industrial wastes. In particular, the focus was on components of those waste types that have the highest potential for recovery in some manner. The intent was to develop an information data base that is representative of the CD&I waste across the State of Minnesota and to build on previous work completed.

The scope of work to address the goal to develop representative statewide data included several different approaches. Four aspects addressed data collection directly from facilities in the state that manage these wastes as part of the transfer and disposal process.

The first approach included a written survey and selected telephone interview process of the public and private landfills in the state that handle CD&I wastes. In addition, the Solid Waste Administrators Association (SWAA) conducted a written survey of their membership. This included data collection in counties without disposal facilities.

The second approach included conducting site visits and management interviews to a selected sampling of these facilities on a statewide basis. This included both landfills and some selected transfer stations. In addition, for the transfer stations in the SWMCB area, transfer station data were compiled by SWMCB for recent years that shows inbound and outbound tonnages and therefore some data on past recovery activities at transfer stations.

The third approach included conducting a waste composition analysis of C&D wastes over a one week period and comparison of the data to other composition analyses of C&D wastes.

Generator oriented data was also sought from home builders and demolition contractors to provide information on the types of materials that are being managed without introduction into the waste disposal stream (at least in some applications). Finally, the project included data collection and analysis from salvage, asphalt, and concrete processors.

The fourth approach was to analyze the data from MPCA and county annual facility reports. Each year, solid waste facilities permitted by MPCA and licensed by counties are required to submit annual reports. The fourth approach was to analyze the data from MPCA and SWMCB county facility reports. Metro area facilities are required to submit monthly reports to the SWMCB counties. The focus of the analysis of this MPCA and SWMCB county data was on specified C&D materials and overall recovery rates.

The process and results of these activities to further characterize the CD&I waste streams in Minnesota are described in the following Section 3 subsections.

3.1 Written Surveys

3.1.1 Landfill Facility Surveys

The focus of questions in both the written survey and the site visit questionnaire covered in Section 3.2 is to gain information on the composition and recoverability of targeted materials

from the C&D and industrial waste streams. Many of the questions in the written survey were similar as those in the C&D site visit questionnaire. The survey requested general site information (i.e., percentage of construction versus demolition waste received at the site, tipping fee, and delivered and in-place densities). The survey also inquired about what recovery is currently being done at the facility, what prevents more recovery at the facility, and the audience's general thoughts on the recoverability of C&D materials. A copy of the written survey is included in Appendix F.

A mailing list for the survey was developed from the MPCA mailing list for annual reports by separating out the demolition landfills (as well as MSW landfills that also accept C&D materials). The industrial waste landfills were scheduled for site visits. The survey was mailed to all known sites that accept C&D materials in the state of Minnesota (except for those sites that were scheduled for actual site visits).

A total of 82 surveys were mailed out in the beginning of January 2007. Twenty-one facilities responded to the survey. Eight additional facilities were contacted by telephone and asked to complete the survey over the phone. From this effort, four more surveys were acquired. In addition, at the completion of the site visits, C&D survey data was completed for an additional ten sites. With these additional surveys, a total of 35 surveys were completed.

The completed surveys came from all areas of Minnesota—six from the metro area, five from the southeast, four from the northeast, four from the southwest, eight from the northwest, and eight from central Minnesota—giving a good representation of the state. The service areas of these facilities also cover the majority of Minnesota. Figure 3-1 shows the general locations and service areas. There is good representation of both public and private entities. Table 3-1 is a matrix developed to summarize the survey and site visit question responses. The following discussion summarizes the various responses.

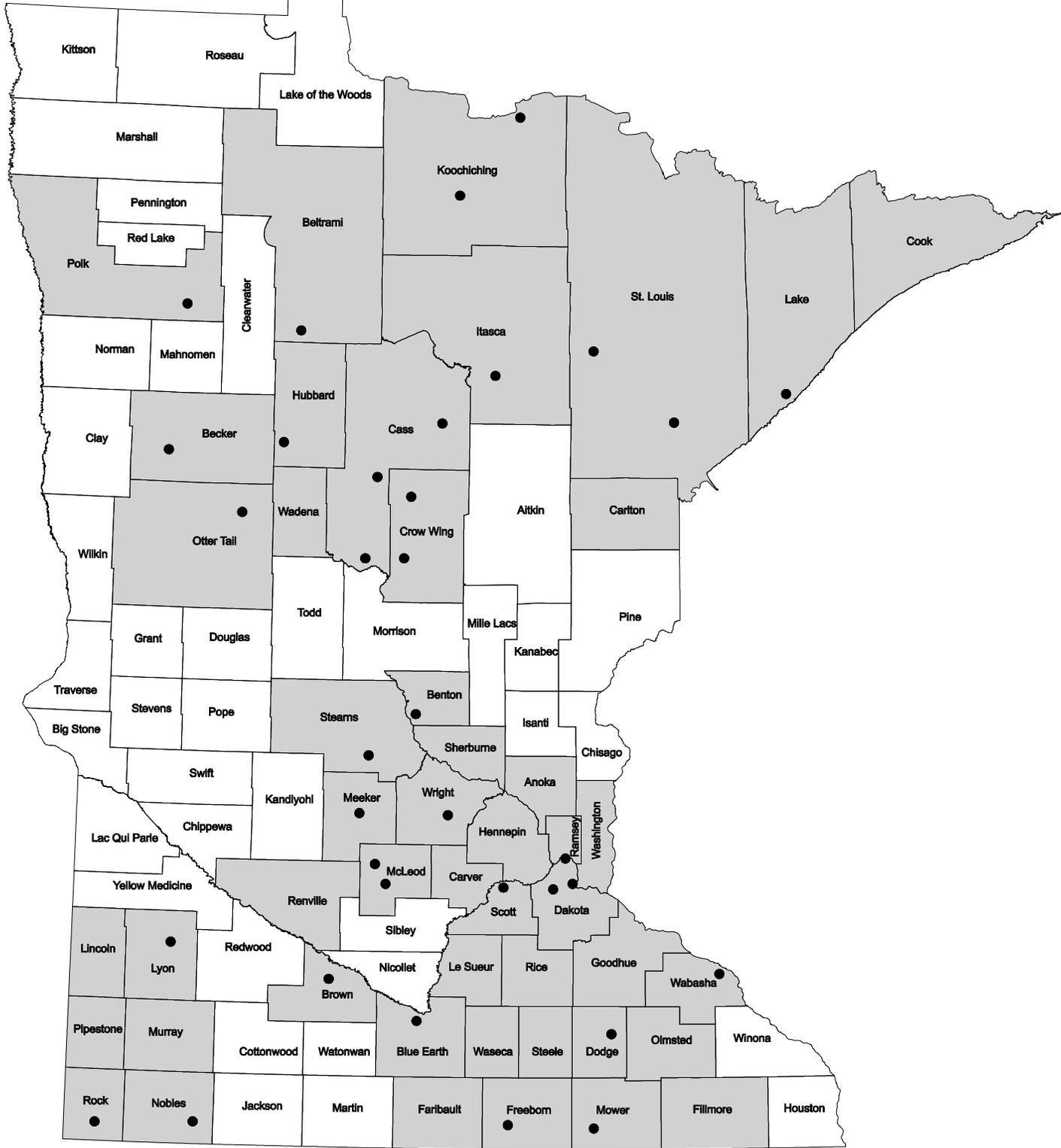
Along with the mailing list, the MPCA provided annual tonnage values for each of the facilities from their 2005 and 2006 Annual Reports. (Twenty-five of the facilities that responded received less than 10,000 tons of waste in the year 2005; the other ten facilities that responded received more than 10,000 tons of waste in 2005.) During 2006, 24 of the facilities that responded received less than 10,000 tons of waste. The other 11 facilities that responded received more than 10,000 tons of waste in 2006.

Three of the facilities only receive demolition debris. Six of the facilities receive approximately 50% construction and 50% demolition debris. Three facilities receive more construction debris than demolition debris, with construction debris ranging from 60% to 70% and demolition debris ranging from 30% to 40%. The remaining facilities generally receive more demolition debris than construction debris, with demolition debris ranging from 60% to 90% and construction debris ranging from 10% to 40%.

The delivered densities ranged from 40 to 2,000 pounds per cubic yard. The average of the delivered densities is approximately 460 pounds per cubic yard. Twenty-two of the facilities did not answer this question. Most of the facilities that did not respond, charge by volume. Most

mentioned that they do not have access to a scale on site. In-place densities ranged from 200 to 1,200 pounds per cubic yard, with the average being approximately 895 pounds per cubic yard.

One of the key findings of this study results in an adjustment to the conversion factor of cubic yards to tons used to project annual C&D tonnages in Minnesota. Prior to this study, the MPCA used a conversion rate of 1,111 pounds per cubic yard to convert deliveries reported in cubic yards to tons as part of the annual reports from facilities. Based on the information obtained in this study from C&D facility operators that have scales and track both weight and volume delivered, the average weight conversion was determined to be approximately 460 pounds per cubic yards. Therefore, the MPCA had previously over estimated the tonnage of C&D generated in Minnesota.



SWMCB C & D AND INDUSTRIAL WASTE STUDY

FIGURE 3-1
C & D FACILITIES PROVIDING INPUT AND SERVICE AREAS



Date: APRIL, 2007
 Drawn By: CKV 06S015

Table 3-1 Construction and Demolition Landfill Survey Summary

Site Name	Total Tons*	Total Tons*	Comp. (%)		Density (lbs/cy)				General Service Area (Counties)	Charge By Vol. or Wt.	Tipping			Growth Potential
	2005	2006	Const.	Demo.	Average	Low	High	In-place			Fee	Recover material	Barriers	
Albert Lea Demolition Landfill	1,305	1,657	0	100	←	Not Calculated		→	Freeborn	Vol.	\$13.50/cy	No	Economics	Concrete
Alex Rubbish Service Inc.	10,065	9,512												
Becker County Transfer Station & Demolition Landfill	3,339	5,635	30	70	na	na	na	unknown	Becker County	Vol.	\$8.00/cy	Yes-concrete	Economics	Shingles & Concrete
Beltrami County Demolition Landfill	2,231	5,475	35	65	200	40	1000	1000	Beltrami	Vol.	\$9.00/cy	Yes-concrete, brick, metals, wood, insulation	Economics Risk of Injury	Metal & Unpainted Wood
BH Heselton Demolition Landfill	454	3,743												
Big Falls Demolition Landfill	144	94	10	90	←	unknown		→	Central & Southern Koochiching	Vol.	\$5.00/cy	No-some done by residents	Low Volume	Wood & Steel
Bonger/Met Con Construction Demolition	1,565	738												
Bray Lake Demolition & Disposal Facility	216	257												
Brookston Demo Debris Land Disposal	63	140												
Burnsville Sanitary Landfill	125,630	107,365	50	50	na	na	na	1100-1200	South Metro (WI to Scott Co.) North of Northfield (Rice Co.) not Carver.	Wt.	\$43.00/ton	Yes-metal	Economics	Metals & Clean Wood
Camp Ripley	159	57												
Canby Demolition Debris Landfill	488	638												
Hass Demolition Landfill														
Chippewa County Demolition Landfill	3,568	3,510												
Clarks Grove Demolition Landfill (WM)	8,139	11,616												
Clay Demolition Landfill	5,975	7,198												
Clay County Sanitary Landfill	999	1,745												
Clearwater County Demolition Landfill	1,049	522												
Cottonwood County Sanitary Landfill	3,879	2,860												
Crosslake Construction Demolition Debris	8,826	8,958	30	70	na	na	na	na	Northern Crow Wing County	Vol.	na	No	Economics	Dimensional Wood
Crow Wing County Demolition Debris	4,940	4,689	30	70	na	na	na	40-45% of gate yardage	20-25% of C&D generated in Crow Wing County	Vol.	\$4.99/cy	No	Low Volume Loads Crushed Contamination	None at their facility
Dawnway Demolition Landfill c/o SKB	39,804	41,788												
Dem-Con Landfill LLC	99,105	114,720	40	60	700	300	2000	unknown	Carver, Scott, S. Hennepin, Chanhassen, Eden Prairie, Rice Co. to Wright Co.	Vol. & Wt.	\$6.50/cy \$37.00/ton	Yes-concrete, steel, wood & asphalt	Economics, Airspace, Commingled Materials	Tear-off Roofing Materials
Dem-Con Landfill LLC		28,196												
Demolition Landfill Services, LLC	26,974	28,612												
Dodge County Demolition Landfill	893	805	50	50	300	200	2000	300	A 10 mile radius around the facility.	Wt.	\$37.00/ton	Yes-unacceptable materials	Economics	Roofing, Wood, Sheetrock
Double D Gravel Inc.	1,151	1,587												
East Central Solid Waste Commission	736	400												
East Grand Forks Demolition Landfill	153	157												
East Polk County Demolition Site	155	273	20	80	←	No scale		→	East Polk 10-15 mile radius	Vol.	\$8.60/cy	Yes-unacceptable materials	Material has no value	None at their facility
East Side Demo Inc.	800	152												
Elk River Sanitary Landfill	157,455	180,511												
Fergus Falls Sanitary Landfill	3,517	3,156												

Table 3-1 Construction and Demolition Landfill Survey Summary

Site Name	Total Tons*	Total Tons*	Comp. (%)		Density (lbs/cy)				General Service Area (Counties)	Charge By Vol. or Wt.	Tipping Fee	Recover material	Barriers	Growth Potential
	2005	2006	Const.	Demo.	Average	Low	High	In-place						
General Waste Disposal/Recovery Svc. Inc.	3,143	4,053												
Geyer Demolition Landfill	2,376	1,449												
Glenwood Demolition Disposal Inc.	2,545	4,935												
Grinning Bear Demolition Landfill	4,976	6,692	60	40	←	No scale	→		30 mile radius around their facility (Brainerd up to Walker)	Vol.	\$6.00/cyt	Yes-steel, cardboard, dimensional lumber, concrete	No Market, Economics, Liability, Expensive to Haul	Shingles, Other Plastics, Sheetrock if had end market
Hansen Demolition Landfill	5,377	5,224	30	70	300	200	500	1200	McLeod, Renville, Meeker, & Carver	Vol.	\$7.50/cy	No	Economics	Cement
Hengel Demolition Landfill	14,274	14,294	50	50	na	na	na	na	Cass & Crow Wing	Vol.	\$6.00/cy	Yes-concrete, asphalt, steel, Cu, Al, wood	Economics Contamination	Wood
Hengel's Westside Demolition Landfill	1,553	2,872												
Henkemeyer Demolition Landfill	9,811	11,872	40	60	na	na	na	na	Benton & Stearns	Vol.	\$9.00/cy	Yes-concrete, Fe, Cu, Al, cardboard, yard waste	Equipment Storage Space	na
Henning Demolition Debris Landfill	2,620	3,773												
Hibbing Demolition Landfill	1,893	2,185	25	75	200	100	400	950	95% St. Louis & 5% Lake, Itasca, & Koochiching	Vol. & Wt.	\$30.67/ton	Yes-clean wood (pallets)	Economics End Markets	Clean Wood, Reusable Items, Shingles, Concrete, & Asphalt
Hoffman Construction Co. Inc.	2,126	2,130												
Hubbard County North Transfer Station & Demolition Landfill	441	596												
Hubbard County South Transfer Station & Demolition Landfill	1,315	2,159	20	80	←	No scale	→		Hubbard, Becker, Wadena, Beltrami, & Cass Counties	Vol.	\$6.00/cy	Yes-concrete, wood, & metal	Economics, no building for separating, mixed loads	Wood & Concrete
International Falls Demolition Landfill	0	161												
Itasca County Demolition Land Disposal	3,382	3,534	75	25	na	1600	2000	na	Itasca County	Vol. & Wt.	\$9.60/cy & \$20.00/ton	No	Economics	Wood
Kandiyohi County Sanitary Landfill	2,097	8,684												
Koochiching County Demolition Landfill	766	939	15	85	NA	NA	NA	NA	Northern Koochiching	Vol.	\$11.00/cy	Yes-residents salvage wood, steel, & insulation	Limited Staff & Time Economics	Dimensional Wood & Steel
Lac Qui Parle County Demolition Landfill	1,879	1,116												
Ladd Demolition & Aggregates	444	1,863	10	90	1000-1500	800	2500	unknown	Brown	Vol.	\$6.50/cy	No	Too Variable Economics	Concrete & Stone
Lake County Demolition Landfill	2,670	1,994	20	80	na	100	2000	unknown	Lake & Cook County, 40 mile wide strip along north shore of Lake Superior	Vol.	\$8.60/cy	Yes-metal	Economics, Volume, Distance to Potential Markets	Concrete & Clean Wood
Lake County Demolition Landfill		56												
Lake of the Woods County Recovery Facility	353	448												
Lakes Area Demolition Facility	3,827	3,582												

Table 3-1 Construction and Demolition Landfill Survey Summary

Site Name	Total Tons*	Total Tons*	Comp. (%)		Density (lbs/cy)			General Service Area (Counties)	Charge By	Tipping			Barriers	Growth Potential
	2005	2006	Const.	Demo.	Average	Low	High			In-place	Vol. or Wt.	Fee		
Lyon County Demolition Landfill	542	173	50	50	400	na	na	1000	Lyon & Lincoln	Vol.	\$5.50/cy	No	Economics No Staff or Storage Space	Shingles
Mahnomen County Demolition Landfill	213	192												
Mark II of Fosston Inc. - Demo Facility	208	617												
Mar-Kit Sanitary Landfill	652	521												
Marshall County Demolition Landfill	441	637												
Meeker County Demolition Landfill	4,833	5,659	15	85	na	na	na	na	Meeker	Vol.	\$7.60/cy	No	No separation system	Concrete & Metals
Mickow Demolition Landfill	446	379	0	100	650	na	na	750	Wabasha & Goodhue	Vol.	\$12.60/cy	No	Time, Loads Crushed	Cement
Minnesota Fall Demolition Landfill	1,070	1,219												
Morrison County Sanitary Landfill	1,941	1,993												
Murphy Bents Demolition Debris Facility	179	1,967	0	100	unknown	na	na	unknown	Nobles & Rock	Vol.	\$4.60/cy	No	Economics Use	na
Murray County Demolition Landfill	638	618												
Nobles County Landfill	1,405	1,220												
Norman County Demolition Landfill	753	736												
Oak Ridge Demolition Landfill	7,933	10,688												
Olmsted County - Kalmar Landfill	3,266	3,878												
Olmsted County - Kalmar Landfill	219	35												
Omega Demolition Landfill	2,263	2,262												
Onyx FCR Landfill Inc. Facility (Veolia ES Rolling Hills Landfill Inc.)	89,115	107,246												
Otter Tail County Demolition Landfill	4,184	3,492	50	50	←	unknown	→		Northeast part of Otter Tail County, 25 mile radius around	Vol.	\$8.60/cy	No	Space & Time	Shingles
Pine Bend Sanitary Landfill	250	94												
Polk County Sanitary Landfill	3,008	4,654												
R & G Construction Co.	223	692												
Red Lake County Demolition Landfill	640	428												
Red Lake County Demolition Landfill - Oklee Site	23	51												
Renville County Sanitary Landfill	3,186	0												
Rice County Landfill	4,912	10,239												
Rock County Demolition Landfill	4,457	5,044	40	60	1000	800	1800	na	Rock, Lyon, Pipestone, Murray, Nobles	Wt.	\$16.00/ton	Yes-metals and wood	Economics, No End Market, Materials Contaminated	Wood
Roseau County SW Transfer Facility	1,772	2,260												
St. Louis County Regional Solid Waste Disposal	17	2												

Table 3-1 Construction and Demolition Landfill Survey Summary

Site Name	Total Tons* 2005	Total Tons* 2006	Comp. (%)		Density (lbs/cy)				General Service Area (Counties)	Charge By Vol. or Wt.	Tipping		Barriers	Growth Potential
			Const.	Demo.	Average	Low	High	In-place			Fee	Recover material		
SKB Lansing Landfill	12,404	14,165	60	40	←		No scale	→	MN-Olmstead, Goodhue, Hennepin, Blue Earth, Mower, Steele, Waseca, Freeborn, Fillmore IA-Worth, Mitchell	Vol.	\$5.60/cy	Yes-concrete & metals	Most marketable materials already removed, economics, no end market	Sheetrock & Roofing
SKB Rich Valley Demolition Waste Mgmt.	27,411	32,174												
SKB Rosemount Landfill	171,911	210,590			400	na	1700	na	I-35W East to WI, HWY 36 South to Red Wing	Vol. & Wt.	\$8.50/cy \$38.00/ton	Yes-wood & metal	Economics	Roofing
Slagle Demolition Landfill	1,539	1,378	25	75	unknown			unknown	Part of Cass County	Vol.	\$8.60/cy			
Spring Lake Demolition Land Disposal	183	154												
Spruce Ridge Resource Management	134,979	91,433	70	30	334	284	385	1300	West Metro, 70 mile radius around facility	Wt.	\$38.50/ton	Yes-wood & concrete	Economics/No Markets	Concrete & Wood
Steele County Sanitary Landfill	4,897	4,592												
Stevens County Facility	3,772	1,633												
Summit Avenue Demolition Landfill	71,363	54,349	15	85	500	125	1000	na	Blue Earth, Le Sueur, Waseca, 50 mile radius around facility	Vol.	\$8.50/cy	Yes-wood, concrete & asphalt	Economics	Metals (Iron) & Wood
TK Demolition Disposal LLC	17,146	17,409	30	70	150	10	500	200	Stearns, Benton, Sherburne	Vol.	\$9.40/cy	Yes-concrete, steel, wood & asphalt	Economics	Steel & Misc. Metals
Todd County Demolition Landfill	2,911	1,409												
Trout Demolition Debris Land Disposal	882	279												
Tupper Demolition Landfill	2,274	482												
Ulland Brothers Inc. - Hibbing	1,338	725												
Valley Demo & Recycling LLC	5,962	7,252												
Veit Demolition Debris Facility	6,109	42,432	60	40	←		unknown	→	Freeborn, Rice, & Mower	Vol.	\$5.60/cy	Yes-steel & concrete	Already picked from T.S., Time, Equipment	Smaller pieces of Steel
Veit Northwood Demolition Landfill	6,109	6,658												
Vonco II Demolition Debris Landfill	154,371	187,300	20	80	na	na	na	na	West and northwest metro area, 45 mile radius around site	Vol	\$8.60/cy	Yes-vinyl siding, cardboard, concrete, asphalt, metals	Economics, Manpower, Feasibility	Wood
Voyageur Industrial Landfill	10,339	0	50	50	na	na	na	na	Northern MN: St. Louis, Lake, & Carlton Counties	Wt.	\$30.00/ton	Yes - metals, cardboard, useable lumber, windows, siding etc.	Most material is Industrial waste.	Clean Wood
Wadena County Demolition Landfill	1,130	788												
Wagner Construction Inc Demo Landfill	804	46												
Wanamingo Demolition Landfill	513	589												
Western Stearns Demolition Facility	4,099	4,928												
Wheaton Demolition Debris Disposal	246	235												
Wodele Demolition Landfill	1,697	1,630												

Table 3-2 shows the result of the revised calculation for C&D delivered to metro area facilities. The lower conversion factor affects the projected tonnage for the three facilities that report by cubic yards. As a result, the overall annual tonnage is reduced by approximately 29%, but it represents a more accurate projection.

Table 3-2 Revising Metro Area C&D Waste Tonnages with a Lower Conversion Factor

	C&D (tons)	C&D (cy)	Cubic Yards to Tons (1,111 #/cy)	Cubic Yards to Tons (460#/cy)	Total Volume Landfilled (tons @ 1,111#/ton)	Total Volume Landfilled (tons @ 460#/ton)
Wm Burnsville Dem/Con	107,365		0	0	107,365	107,365
Carl Bolander & Sons – Dawnway Demo		181,687	100,927	41,788	100,927	41,788
Pine Bend SLF	94		0	0	94	94
SKB Rich Valley Demo.	139,887		0	0	139,887	139,887
SKB Rosemount Demo.	210,590		0	0	210,590	210,590
SKB Rosemount Industrial			0	0	0	0
WM Spruce Ridge	91,433		0	0	91,433	91,433
Dem-Con Companies LF		498,784	277,075	114,720	277,075	114,720
WM Elk River Dem/Con LF	180,511		0	0	180,511	180,511
Veit VONCO II		814,349	452,371	187,300	452,371	187,300
Xcel A.S. King Plant			0	0	0	0
Veolia ES Rolling Hills LF	107,246		0	0	107,246	107,246
Total	837,126	1,494,820	830,373	343,809	1,667,499	1,180,935
				% Difference:	29.2% reduction	

The majority of these facilities charge by volume versus by weight. The tipping fee for facilities that charged by volume ranges from \$4.60/cy to \$13.50/cy. The average tipping fee for the facilities that charge by volume is approximately \$7.80/cy. Four facilities charge by both weight and volume. Five facilities charge by weight. The tipping fee for facilities that charge by weight ranges from \$16.00/ton to \$43.00/ton. The average tipping fee for facilities that charge by weight is approximately \$32.20/ton.

Of the facilities that completed surveys, approximately 63% (22/35) perform some recovery on site. One facility did not answer this question. The majority of these facilities recovered concrete, brick, metal, and wood. Economics is the major barrier mentioned that prevents a facility from recovering more materials on site. Responders mentioned that there is not enough staff, equipment, and time to effectively recover enough materials to generate a benefit to the facility. Other barriers included:

- ◆ Interference with landfill operations
- ◆ Risk of injury
- ◆ Contamination of materials

- ◆ Commingled materials
- ◆ No end market
- ◆ Liability
- ◆ Storage space

A few different materials were mentioned that are believed to have the most potential to increase the percentage of recovery of C&D materials. Concrete was the most common material mentioned, followed by roofing materials, wood, and metal.

Approximately 77% (27/35) of the surveys received provided information on what cities and counties could do to help promote recovery of C&D materials. Approximately 57% (20/35) of the surveys received provided insight on what the State could do to help promote more recovery of C&D materials.

Listed below are a few responses to what cities/counties could do to help promote more recovery of C&D materials. Most comments were focused on trying to separate materials prior to them arriving at a landfill.

- ◆ In order for C&D materials to be recycled, there needs to be a business that accepts and provides markets for the C&D material. While some markets already exist for certain C&D materials (e.g., concrete and certain metals), there is no widely known end market for other C&D materials (e.g., sheetrock). Some materials, like dimensional lumber, might allow for give-away programs.
- ◆ Educate generators on what C&D materials can be recycled so they take care to separate out those materials when constructing or deconstructing a building. Increase advertising for businesses that accept recycled C&D materials. Inform generators and landfills of places they can take the recycled materials.
- ◆ Create incentives for generators to separate C&D material into categories prior to bringing it to a landfill. An example would be to reduce or waive tip fees for separated materials.
- ◆ Provide funding for equipment and staff to separate material after it is delivered to the landfill.

Many responses as to what the State can do to help promote recycling of C&D materials were similar to what the cities/counties can do to promote recycling. Examples include educating generators about recyclable C&D materials, providing end markets for materials, and funding for landfill equipment and staff. Highlighted below is another response to what the State can do to help promote more recovery of C&D materials.

- ◆ Mn/Dot could create a specification allowing the use of tear-off roofing in pavement mix design.

Approximately 74% of the surveys received provided additional comments on the potential to recover materials from the C&D waste stream. Below are some additional comments. For the most part, the survey responders believe that there is potential to recycle C&D material, but that it is not economical.

- ◆ There is still plenty of illegal dumping. The rules of proper disposal still need assistance to be enforced.
- ◆ A large portion of what we receive is wood. If this material could be pulled out and ground up it could be used for a fuel source. With time and some effort this wood could also be salvaged for crafts, etc.
- ◆ There is a lot of potential to recover C&D if time, money, and staff are available.
- ◆ The material we receive really doesn't have any value. The bulk of it is demo material.
- ◆ It is not economical to spend time sorting material at the landfills at this time.
- ◆ Additional restrictions without funding cause hardship for honest people and force some facilities to break the law.
- ◆ Larger facilities could have designated areas for storing concrete/brick, lumber, asphalt, steel, etc. Smaller sites may not have the space to stockpile separated materials. However, areas with less permitted airspace may be encouraged to maximize what they have.
- ◆ Economics and volume of C&D material received at a facility are big drivers for Greater Minnesota.
- ◆ There is plenty of potential, but without financial incentives, intense public education or end markets, especially in rural areas, nothing more will ever occur.
- ◆ On-site recovery has a tendency to interfere with basic operation of the landfill.
- ◆ Ideas to promote more recovery of this waste stream may be successful in highly populated areas, but may cause hardship in rural counties.

The written survey also asked the site managers to include information about the waste composition of the C&D material received at their facilities. The material percentages present at the facilities were similar to what was found in the waste sorts performed at the SKB C&D facilities, with wood, sheetrock, roofing, concrete and brick comprising the majority of the waste stream. Below is a summary of the site managers' observations of the recoverability of certain C&D materials.

- ◆ The recoverability of corrugated cardboard was split 50/50. Some survey responders believe that most of the material they see at their site is contaminated with paint or other

residues. Other facilities pick out the cardboard by hand as it arrives at the facility and take it to a recycling center or transfer station for further processing.

- ◆ Most responders believe that other paper products received at their facility are contaminated and not recoverable. Many of the facilities noted that they do not accept paper products other than corrugated cardboard.
- ◆ Marketable plastics and other plastics received at the facilities are mostly contaminated and not recoverable. A few facilities did not allow this type of waste at their landfills.
- ◆ Most responders believe that ferrous metal is recoverable. A lot of this material is already recycled prior to loads coming to the landfill. Several sites separate out ferrous metal. Sometimes equipment is required to recover this product.
- ◆ Some responders think other metals also had the potential to be recovered and reused; others believed it is not recoverable.
- ◆ Textiles and carpets are usually too contaminated to recover. Often they are intact but mixed with other materials that contaminate them. Sometimes they are still attached to other materials. Some areas accept carpet as MSW waste so it is not seen in the C&D waste stream.
- ◆ Half the responders believe that dimensional wood is recoverable and half believe it is contaminated or not recoverable. This material is usually broken in smaller pieces making it very labor intensive to recover. It has potential to be used as a fuel source, but a more economical recovery method needs to be employed than picking it out at the landfill working face.
- ◆ Most responders believe that other wood products are not recoverable.
- ◆ A majority of the responders believe that concrete is recoverable. Some of the material is rejected material that the contractors did not recycle. These loads contain too much rebar, making the concrete difficult to recover. Some facilities were limited by not having a place nearby to bring loads of concrete, and its weight makes it expensive to transport long distances. Facilities usually are required to accumulate large amounts of concrete to justify crushing.
- ◆ Brick is generally recoverable and usually is grouped with concrete.
- ◆ Sheetrock is believed to be contaminated or not recoverable. Some comments focused on there being no end market for sheetrock.
- ◆ Some responders believe roofing is recoverable, especially when it comes in a load by itself. One manager thought it might be helpful if they had a grinder on site to help process the material, provided they had enough volume. Others believe it is too labor intensive to bother recovering (littered with nails).

3.1.2 Solid Waste Administrator's Association (SWAA) Survey

The Minnesota Solid Waste Administrator's Association (SWAA) was actively involved in this project to the point of completing a separate survey of their membership. The SWAA survey focused on issues of specific importance to them. The text in this subsection was developed by Doug Morris, Crow Wing County Solid Waste Administrator on behalf of SWAA.

The purpose of the SWAA Survey was to identify the Greater Minnesota's county solid waste administrator's issues and concerns related to C&D and industrial waste. A copy of the survey is provided in Appendix G.

Greater Minnesota faces the issue that 46% of the population lives in 96.4% of the state land area. The population density of Greater Minnesota is 29 people per square mile compared to the metro area that has a population density of 945 people per square mile. This greatly affects the economy of scale as outlined by the lack of facilities in many of the counties. Many counties, to ensure they do have a facility, must subsidize a county operated facility. Another issue for Greater Minnesota is the cost of moving the materials to a market or viable disposal option.

There are 80 counties in Greater Minnesota plus Western Lake Superior Sanitary District (WSLLD). A total of 73 surveys were completed, for a 90.1% return rate. The survey results are compiled in Table 3-3 and discussed below.

1. Are their adequate disposal options available within your county concerning C&D?

- ◆ Twenty SWAA respondents, or 27%, consider existing disposal facility opportunities inadequate to address the C&D issue within their county. This relates to the amount of permit-by-rules (PBR), illegal dumping or burning that county residents utilize to address the disposal of this material.
- ◆ In some cases, due to the location of the facility and hauling distance, certain areas of many other counties are not easily accessible to existing C&D facilities.

- ◆ Fifty-three SWAA respondents, or 73%, consider existing disposal facilities adequate to address the disposal of C&D waste in their county. Many SWAA members are worried that as additional MPCA “guidance” (that is treated as rules) come out, additional costs will be added on to existing facilities or on any new/proposed facilities. Will these facilities continue to operate or close in the future, thus removing existing disposal options and increasing the number of counties not having adequate disposal coverage?

2. Does your county still utilize Permit-by-Rule for demo waste?

- ◆ Only seventeen SWAA survey respondents, or 23%, do not utilize PBR for the disposal of demolition waste. Of these, three counties do not consider existing disposal facility opportunities adequate to address the C&D issue within their county. This raises the question of the adequacy of the disposal of this material in these areas of the State.
- ◆ One county reported that MPCA issued a PBR to a private operator three years ago and they are still operating off it. This raises the question of how closely is MPCA enforcing the one-year limit and how uniformly is the MPCA regulating this throughout the State.
- ◆ Even though this survey shows many counties still utilizing PBRs, in reality many have not seen an application for years since their county has a C&D landfill that services their area. Many of the counties still leave this option open on a case-by-case determination. One of the big areas where PBRs are issued is for farmers. Also, some of the very large counties do have multiple C&D landfills, but distance is still an issue in remote areas so they use PBRs to address these areas.
- ◆ An ongoing issue with most counties is lack of enforcement concerning illegal dumping. C&D waste gets disposed of all over and not into a permitted facility or within a PBR area.

3. Does your county own a C&D landfill?

- ◆ Thirty-six respondents, or 45% of the counties, operate a C&D facility. Eight of these counties have a C&D disposal facility as part of their integrated solid waste management system—a one-stop-service for their residents. They either have a WTE or landfill facility to address MSW.

3.a. If yes, why?

- ◆ All of the counties that do have a C&D facility feel they are providing a necessary service to their residents/community. In many cases, their facility is the only disposal option for the residents of the county.
- ◆ A couple of counties commented that they did try a privately owned landfill but found it more advantageous to be publicly owned. One reported the private company could not

operate financially under existing state guidelines, and the county took over operations to ensure a facility within their county.

- ♦ Many counties pointed out there are many more opportunities for illegal dumping than legal management options for this material.

3.b. If you do have a county C&D landfill, what is your average volume during the last 5-years?

- ♦ Of the county C&D landfills replying, the average volume was 9,000 cubic yards per year. The volumes ranged from a low of 2,000 cubic yards per year to a high of 28,000 cubic yards per year.

What is your current tip fee?

- ♦ This has a range from a “free” service being provided by the county to a high of \$25 per cubic yard.

3.c. Does your current tip fee cover all expenses or does your county subsidize its operation?

- ♦ Seventeen SWAA respondents of the 36 who own a C&D facility, or 47%, are subsidizing their C&D operations. In reality this is higher, as some counties also operate other aspects of their integrated solid waste management system at the same site; thus, operation of the C&D has a hidden subsidy due to the other operations at the site to offset the true cost.

3.d. What are your issues or concerns with operating a C&D landfill?

- ♦ One of the greatest concerns was keeping costs down and still meeting State standards. A significant concern is how new guidelines will impact their next permit reissuance.
- ♦ Inspection - are private operators doing a good job of keeping non C&D out of their sites?
- ♦ Non-demo materials are the biggest problem—getting in clean loads. Residents and contractors alike try to get by with whatever they can; it’s impossible to watch everyone at all times.
- ♦ Need better training for building contractors on what is acceptable and what is not.
- ♦ Many question the future requirement for lined cells and monitoring wells. This ties in with the issue that a large portion of Greater Minnesota C&D disposal service is being provided by the county and they are subsidizing operations to keep the tipping fee low to ensure people actually use it versus illegal methods. Due to the low volumes received at these facilities, fixed costs per cubic yard are much higher. In addition, with the

increased cost of operation, there is even less likelihood of a private facility starting up in these counties. Many feel this is a local issue and should be based on local circumstances.

- ◆ There are concerns that county owned, low-volume C&D disposal facilities could be priced out of existence, and this material will be forced to go to a MSW landfill or illegal disposal will increase. In addition, as tipping fees go up, some counties are already seeing an increase in illegal dumping.
- ◆ Being able to permit future expansion.
- ◆ Many county facilities do not offer sorting services and require their loads to be very clean. Because of this, many of the large volume haulers do not utilize their county facility.
- ◆ Fixed cost requirements like annual survey and groundwater monitoring make it difficult for the small volume landfill to be competitive.

3.e. What would you like changed concerning C&D landfills?

- ◆ Many SWAA survey responders want to see more opportunities for reuse and recycling.
- ◆ Reduce the operating requirements for the small-volume landfills. For example: instead of requiring an annual topographic survey, allow the survey to be completed once every three years or every 15,000 cubic yards, whichever comes first. Also question monitoring wells unless the water table is at risk.
- ◆ Rules for non-friable asbestos are too tight. Residents do not want to bag it, so they hide it in their loads and don't report it. Maybe it would be better to have a pre-identified place at the facility where they can dump it, after which dirt would be spread over it.
- ◆ Less strict in some areas. What is the difference between an empty dried out paint can and a board with paint on it? What harm is a plastic lawn chair going to do? Granted we do not want to make a habit of accepting these items, but a certain level should be acceptable.
- ◆ Need to distinguish between C&D landfills and landfills that also accept industrial waste.
- ◆ Guidelines are OK for a short term, but they need to be incorporated into rules. Issue also with staff interpretations of ambiguous rules and guidance.
- ◆ Give a break to the well-run landfills. There should be incentives for doing things well.

4. Are there any recycling opportunities for C&D waste within your county?

- ◆ Thirty-five counties, or 48%, said they did not know of any recycling opportunities within their county. In reality this may be lower. Many contractors, depending on the facility being demolished, do recycle or reuse items from individual demolition sites. This is also dependent on the contractor.
- ◆ Some report an increased interest of looking at this material as a potential for recycling.

If yes, what are they?

- ◆ The largest area is concrete and asphalt. With the high metal prices, metals are also being removed at the job site and the amount being seen at the C&D facilities is not large. Some C&D facilities are also removing metals as it comes in. Shingles were also identified by two counties.
- ◆ Some of the facilities have a sorting area or pull out items and allow these items to be removed for reuse or recycling. St. Louis County has a re-use building at the collection site.
- ◆ Houston County residents are able to utilize the Resale Store in La Crosse, Wisconsin.
- ◆ In general most recycling is in demolition with little to no recycling on new construction.
- ◆ Dodge County is grinding dimensional lumber for wood chips. Also, St. Louis County is separating clean wood for local public utility biomass project.
- ◆ WSSLD reports material sorting and recycling at facilities like “Demo-Licious” in Duluth and AA Rolloff Services in Superior, Wisconsin.

3.2 Site Visit Summary

3.2.1 Industrial Landfill Site Visits

3.2.1.1 Introduction

Site visits were conducted at four industrial landfills in Minnesota; SKB Rosemount Landfill (SKB), Burnsville Sanitary Landfill (Burnsville), Veolia ES Rolling Hills Landfill (Veolia), and Spruce Ridge Landfill (Spruce Ridge). All four landfills are located around the metro area.

The service area for these facilities was generally around the metro area. Veolia said they get customers from all over the state of Minnesota, not just the metro area. SKB mentioned that they occasionally get industrial waste from Iowa.

The industrial landfill site visits included an interview session and observation session. During the interview, the landfill managers answered questions about general characteristics of the site and industrial waste stream, acceptance procedures, recoverability of this waste stream, and barriers to recoverability (see Site Interview Questionnaire in Appendix H). After the interview, a visit was made to the active face where observations of the industrial waste characteristics were made. Selected photos taken are provided in Appendix I. The landfill managers were

forthcoming with information about the specific wastes that were observed at the active face (what the waste was and the customer). Three of the facilities place industrial waste in a lined cell with C&D waste. SKB was the only facility that had a separate lined cell dedicated for industrial waste.

3.2.1.2 Industrial Waste Composition

Table 3-4 provides a summary of the total annual tonnages of industrial waste delivered to each of the landfills during 2005. The tonnages range from a low of 64,025 to a high of 403,063 with the total industrial waste tonnage delivered to these four sites equaling 864,693.

Table 3-4 Summary of 2005 Industrial Waste Deliveries

Site	Data Period ¹	Annual Tonnage
SKB Rosemount Landfill	2005	298,595
Burnsville Sanitary Landfill	2005	99,010
Veolia ES Rolling Hills Landfill	2005	403,063
Spruce Ridge Landfill	2005	64,025
TOTAL		864,693

¹From MPCA 2005 Annual Report.

The industrial waste materials were initially categorized into 17 different categories. The category accuracy was discussed during the interviews. While all the facilities did not get waste in every category, they received waste in at least some of the categories. SKB added some categories to characterize waste that did not fit into the original categories. SWMCB added additional comments to the interview questions and waste categories. Auto shredder fluff was added to the industrial waste categories as a result of these comments. Based on the categories and the information provided by the Landfills, pie-charts were developed showing the waste composition at each site. These are shown in Figures 3-2, 3-3, 3-4, and 3-5.

All four facilities were able to provide a breakdown of their waste stream over a one-year period. This year varied from site to site. Some facilities (Spruce Ridge and Veolia) were able to give an approximate breakdown of waste composition based on their 2006 annual data. SKB and Burnsville gave a breakdown of waste composition based on their 2005 annual data (site visits were conducted at different times of the year).

Contaminated soils were the most prominent industrial waste material accepted at all four facilities. Three of the four facilities mentioned that there is some seasonal variation in the amount of industrial waste delivered to the site throughout the year. Generally the waste stream diminishes somewhat during winter because contaminated soils cannot be excavated when the ground is frozen. Spruce Ridge indicated less variation in their waste stream. This could be because they receive a significant amount of recycling residuals such as crushed glass that is not marketed for use in making new glass containers. Ash and asbestos were the next two common materials in industrial waste. Sludges and recycling residuals also made up a portion of the waste stream.

Figure 3-2 SKB Rosemount Facility Industrial Waste Composition

**SWMCB Industrial Waste Study
Site Visits/Interview Data Collection
SKB Rosemount Facility
Industrial Waste Composition**

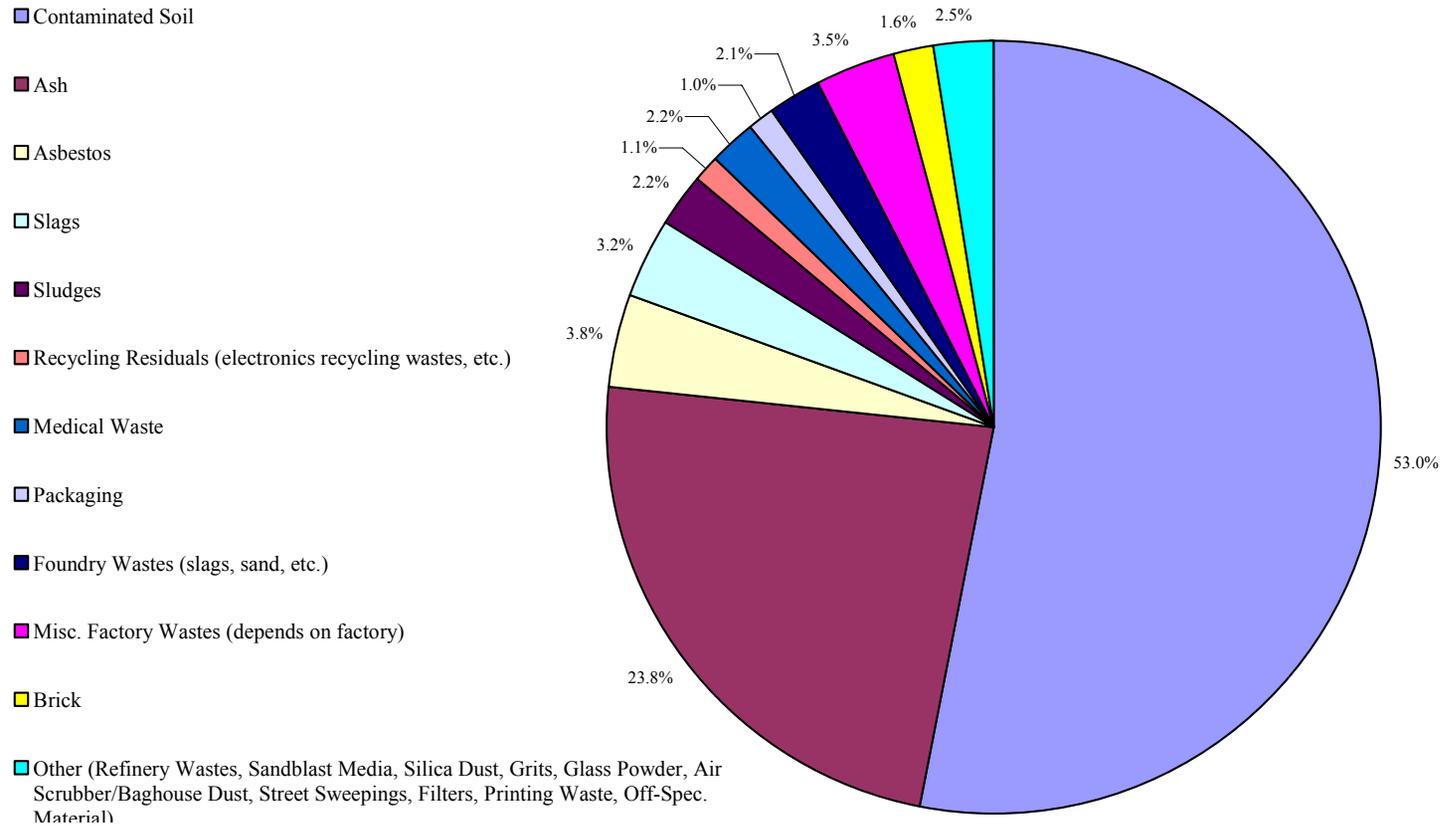


Figure 3-3 Veolia ES Rolling Hills Landfill Industrial Waste Composition

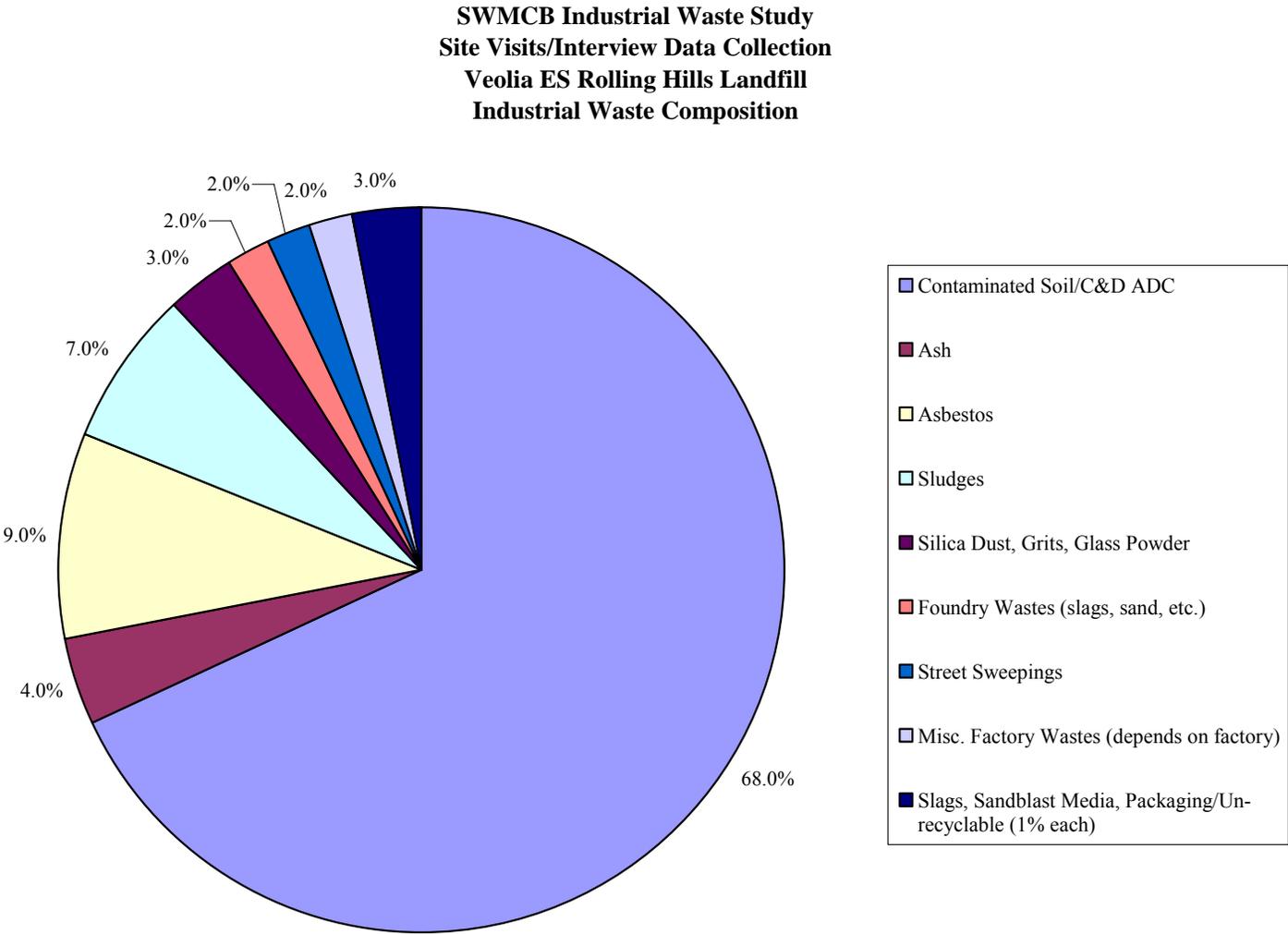


Figure 3-4 Spruce Ridge Landfill Industrial Waste Composition

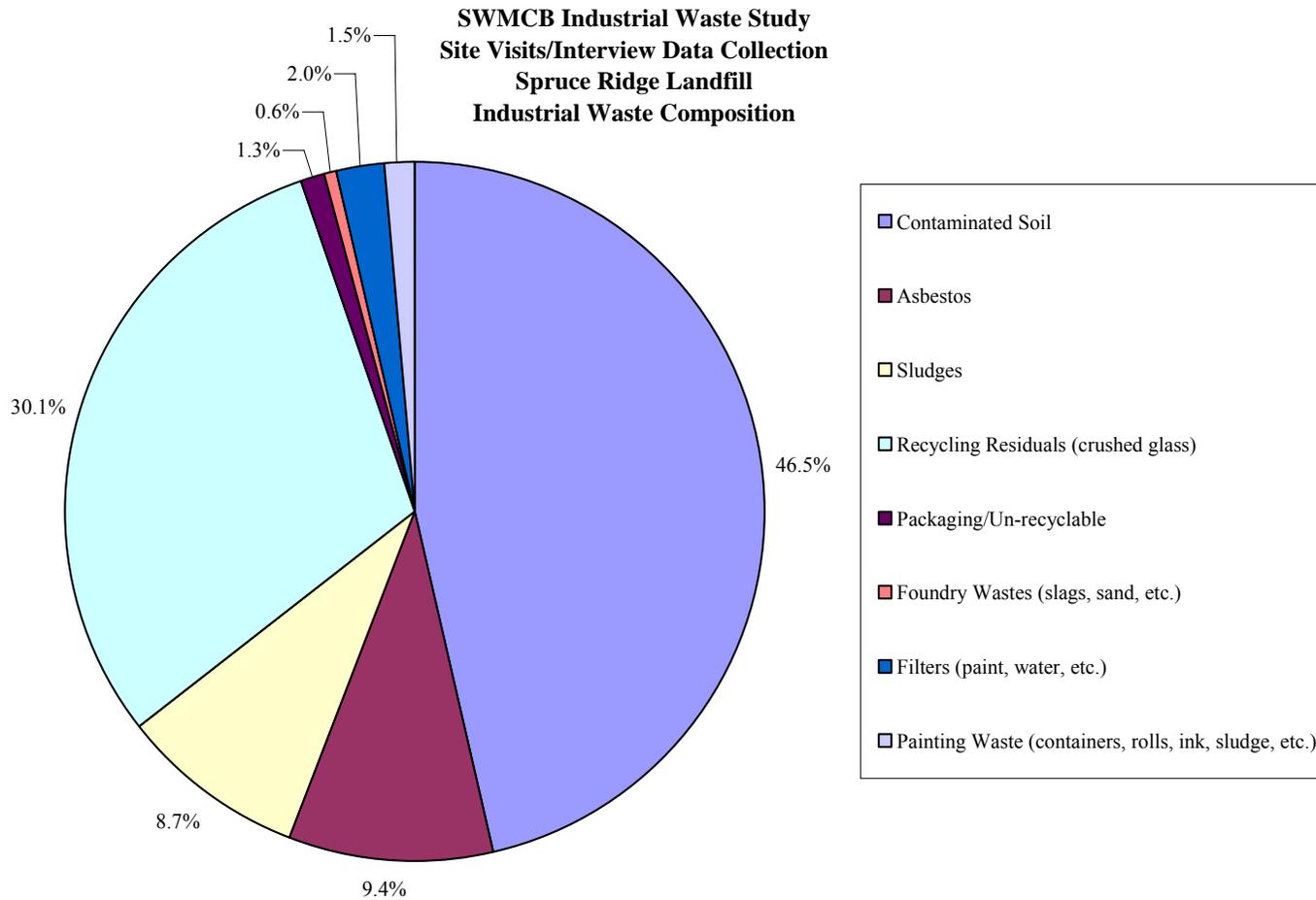
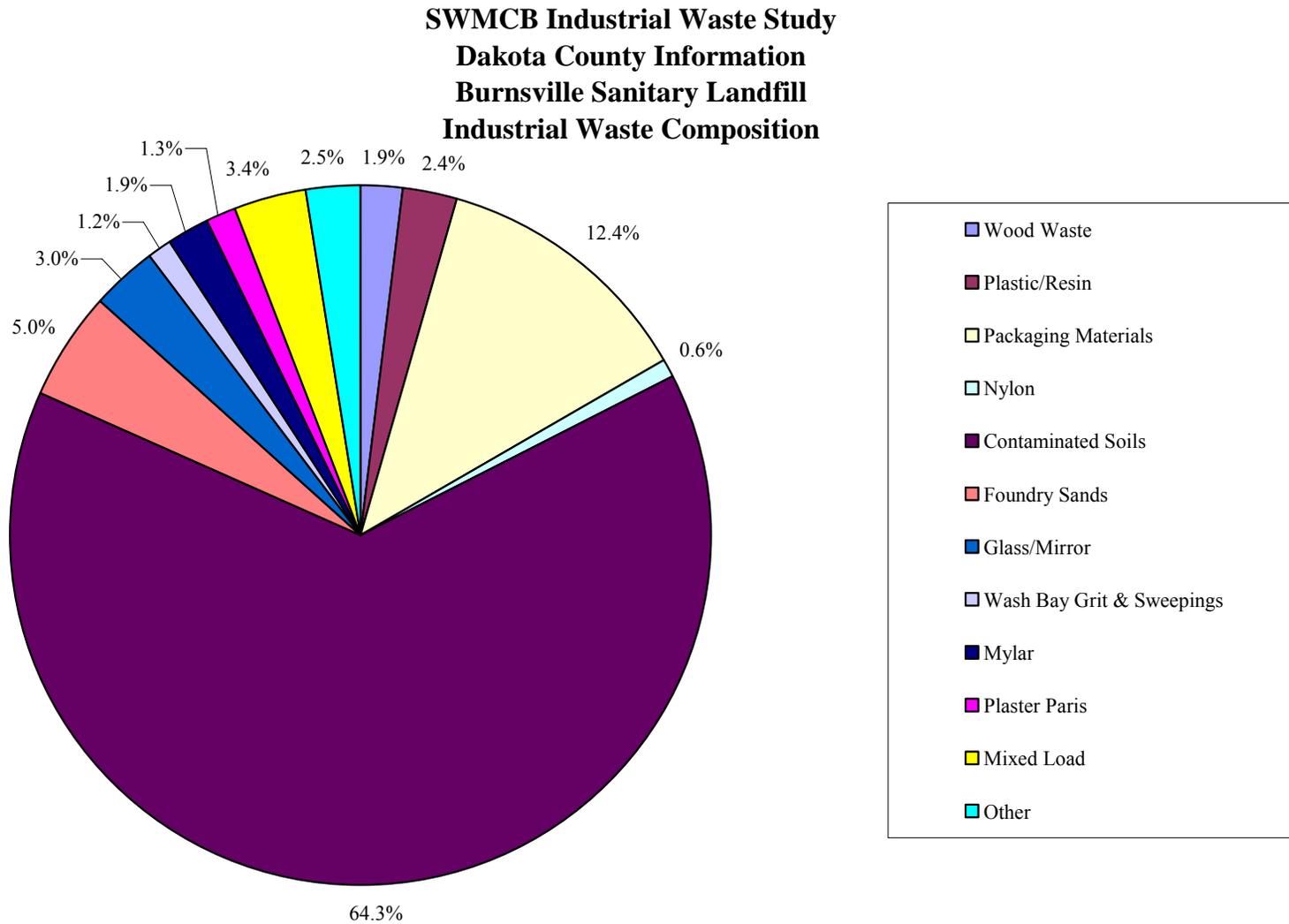


Figure 3-5 Burnsville Sanitary Landfill Industrial Waste Composition



An example of a common recycling residual is crushed unrecyclable glass from material recovery facilities (MRFs). This crushed glass is used as road base for roads leading up to a lined cell at one facility. This material is also used as drainage material in leachate recirculation cells and will be used for drainage material in a bioreactor cell that is currently being built. Two of the less prominent categories that were noticed during site tours include Miscellaneous Factory Wastes and Packaging.

The industrial waste stream contains the by-products of manufacturing processes. An example of a by-product is sawdust from a window manufacturing company. This sawdust contains vinyl chips limiting its alternative uses. One of the facilities is able to use this material as floor-dry around the site to help keep haul roads navigable. Other examples of by-product materials include, balloon shreds from a balloon manufacturing company and acoustical sound insulation from a speaker manufacturing company. During the site visits it was noticed that most of the packaging materials (cardboard boxes or plastic bags) were contaminated. In some instances, the cardboard boxes were the means to transport the wastes (such as silica dusts that could become airborne if not controlled). Overall, potentially recyclable packaging represents a relatively low percentage of the total industrial waste delivered and much of it is too contaminated to safely recycle.

All of the facilities used some of their incoming material as alternative daily cover. This material includes contaminated soils, sand blast media, and C&D processing facility fines. Some sites create berms with contaminated soils within the active cell to help contain stormwater. These soils were also spread in the active face to provide an area for trucks to back-up and unload their waste.

3.2.1.3 Delivered Density

It was agreed upon by all four facilities that it is difficult to give an average delivered density. The density of delivered loads varies depending on what materials are in the load. A load of contaminated soils typically is denser than a load of foundry sand. SKB uses 1.3 tons per cubic yard as an average of the delivered density. This factor is recognized by the Department of Revenue and was determined by collecting over ten years of data.

3.2.1.4 Waste Acceptance Procedures

All of the facilities have acceptance procedures and guidelines that are followed prior to accepting a new customer or waste material. The procedures include:

- ◆ Making sure the waste is within the site's Industrial Solid Waste Management Plan;
- ◆ Laboratory testing, and
- ◆ Written application.

The application requests detailed information about the waste material. This helps the facility understand what types of laboratory tests must be performed on the material to make sure it is acceptable at the site and can be approved for delivery by the company. When the waste/customer is approved, they are given an identification number that accompanies every load they bring to the site. Also, each load is manifested.

Most facilities also have inspection procedures for accepting customers and incoming waste materials. These inspections include visual inspections prior to crossing the scale, visual inspections at the working face, and laboratory tests including chemical analysis (dictated by the waste material). Some sites randomly sample loads and others followed a sampling schedule. One facility samples irregular customers each time they come to the facility. When a load requires a laboratory sample, the hauler is directed to unload in a special area until the load is approved. Once approved, the load is transferred to the active face for disposal. One site mentioned they send annual re-certification letters to all their customers to confirm that the existing client's waste composition has not changed.

3.2.1.5 Gate Rates

The gate rate for these facilities varied from \$25.00 to \$75.00 per ton. Three of the four facilities mentioned that the actual rate depends on the type of waste a customer brings to the site, for example denser wastes are typically charged at lower rates.

3.2.1.6 Industrial Waste Recovery

When asked about source separation and recovery at generator sites, there was a mixed response. Managers at two of the sites were aware and two were not aware of some recovery being done at generator sites. Some of the facilities accepted by-products from recycling facilities themselves.

None of the four facilities does a significant amount of recovery. One site has a magnet that is used to recover metal from incinerator ash. Two did no recovery at all of this waste stream. One used a different approach and requests the haulers to separate out materials. Haulers are allowed to keep a rolloff container near the active face to separate out unacceptable materials.

Metal was the only material in these facilities' industrial waste stream that had a local market. Two of the site interviewees mentioned local recycling facility locations where they could take recovered metal for further processing.

The recoverability of some industrial waste materials, including other types of metals, glass, lightly impacted soils, and foundry sand, could be increased. Glass may be used as drainage material and road base. Lightly impacted soils could be used as general fill for construction projects. A majority of used foundry sand is already being collected and used in concrete mixes in Iowa.

Foth contacted a representative from Metal Casters of Minnesota (MCM) to discuss other beneficial uses for foundry sand. MCM is a non-profit organization that supports foundries and dye-cast companies with legislative issues. It is important to note that foundry sand is reused within the foundry industry several times prior to becoming waste. Currently the MPCA considers foundry sand as a by-product used in portland cement manufacturing as a beneficial use. However, there are no portland cement manufacturing companies in Minnesota. There are two portland cement manufacturing companies in Iowa.

Some of this foundry sand by-product is sent to Iowa for reuse at the portland cement manufacturing companies. To ease the transportation fees and increase the volume of materials, the foundries were considering a staging area in Minnesota where they could stockpile approved foundry sand for transport to the manufacturing plants in Iowa. This idea has yet to be realized due to the high costs associated with acquiring a fully enclosed building for stockpiling (to meet the state stormwater requirements). The MPCA is currently reviewing a pilot project to use foundry sand in road construction projects.

Occasionally foundries will co-dispose their foundry sand and baghouse dust. The fines generated from this type of disposal prevent these materials from being able to be used in the portland cement mixture, they must be landfilled. Foundry sand can also be used as alternative daily cover at landfills.

Some ideas offered for increasing the recoverability of the industrial waste stream included:

- ◆ Some types of contaminated packaging for a fuel source;
- ◆ Other types of metals (ex. copper and metals from plating sludges);
- ◆ Lightly impacted soil in construction projects; and
- ◆ Glass for drainage material.

The main barrier mentioned to recovering more material from the industrial waste stream is that these materials have no value/market. Most of the material is contaminated and some of the material is not safe to recover (e.g., airborne particulates). In some cases, customers are bringing the materials to be landfilled and paying for that service. It could be damaging to a company's reputation or dangerous if off-spec material got back out on the market.

When asked if the government could help increase the recovery of the industrial waste stream, the general response was no. It is believed industrial waste is generally by-product materials and there is not much left to recover that is not already being recovered.

3.2.2 C&D Landfill Site Visits

3.2.2.1 Introduction

Site visits were conducted at nine C&D landfills in Minnesota; SKB Rosemount Landfill (SKB), Burnsville Sanitary Landfill (Burnsville), Dem-Con Landfill LLC (Dem-Con), Dodge County Landfill (Dodge County), Spruce Ridge Landfill (Spruce Ridge), Vonco II Demolition Debris Landfill (Vonco II), Itasca County Landfill (Itasca County), Rock County Landfill (Rock County), and Summit Avenue Demolition Landfill (Summit). A phone interview was conducted for the Northeast Otter Tail Demolition Landfill (NEOT). These ten landfills are located all around the state of Minnesota. The service area for these facilities is generally the entire state. Itasca County receives waste from the northeast portions of the state, while Rock County receives waste from the southwest portions of the state. NEOT receives waste from the north

western portion of the state and Spruce Ridge and Summit receive waste from the south eastern portion of the state. There are several facilities that also received waste from the metro area.

The C&D landfill site visits included an interview session and observation session. During the interview, the Landfill Managers answered questions about general characteristics of the site and C&D waste stream, recoverability of this waste stream, and barriers to recoverability (see Site Interview Questionnaire in Appendix J). After the interview, a visit was made to the active face where observations of the C&D waste characteristics and observations of recovery were made.

3.2.2.2 C&D Waste Composition

Table 3-5 provides a summary of the total annual tonnages of C&D waste delivered to each of the landfills during 2006. The tonnages ranges from a low of 805 tons to a high of 210,590 tons, with the total C&D waste tonnage delivered to these ten sites equaling 692,108 tons.

Table 3-5 Summary of 2006 C&D Waste Deliveries

Site	Annual Tonnage	% Construction	% Demolition	% Transfer Station	% Roofing
SKB Rosemount Landfill	210,590	35	27	35	3
Burnsville Sanitary Landfill	107,365	50	50		
Dem-Con Landfill LLC	28,196	40	60		
Dodge County Landfill	805	50	50		
Spruce Ridge Landfill	91,433	70	30		
Rock County Landfill	5,044	40	60		
Itasca County Landfill	3,534	75	25		
Summit Avenue Landfill	54,349	15	85		
Vonco II Demolition Landfill	187,300	20	80		
Northeast Otter Tail Landfill	3,492	50	50		
TOTAL	692,108				

All of the facilities receive both construction and demolition waste. Three facilities receive approximately 50% construction and 50% demolition waste. Four facilities receive more demolition waste than construction waste (60-85% versus 15-40 %). There were two facilities that receive more construction waste than demolition waste (70% versus 30%). Because the waste sort was completed at the SKB Rosemount facility, a more detailed breakdown of their customer types was developed. They receive approximately 35% construction, 27% demolition, 35% transfer station, and 3% roofing. These percentages can vary from year to year for a single facility depending on building/demolition projects in their service area.

The C&D waste materials were initially itemized into 15 different categories. While all the facilities did not get waste in every category, they received waste in at least some of the categories. Based on the categories, the landfill operators were able to provide approximate percentages that materials were present. The extent of different materials varied among

facilities. For example, some facilities received whole loads of roofing material while other facilities received very little roofing material. Generally, the C&D waste materials encountered during the site visits were similar to what was discovered during the waste sort.

Several facilities mentioned they are seeing less concrete and metal in the C&D waste stream than previously. It is believed that a lot of their customers are separating this material prior to bringing loads to the landfill. This material may be separated out because it is less expensive to take the concrete to a facility that can grind the material than bringing it to a landfill. Some metals currently have a good market.

Most of the facilities received some cardboard. Some of the facilities are not allowed to accept this material but see incidental amounts that are contaminated packaging material. Rock County mentioned that they ask contractors to pull out this material prior to delivery. A few sites take the time to separate out clean cardboard on site and send it to a nearby recycling facility.

The majority of the waste stream was consistent with what was observed during the C&D waste sort at the SKB facilities. The waste was primarily composed of wood, sheetrock, concrete, and roofing with small amounts of cardboard packaging, plastics (vinyl siding and sheet plastic), textiles, metals, and other paper. Site visit photographs showing examples of waste material in the C&D waste stream are provided in Appendix K.

All ten facilities agreed that there was seasonal variation in the amount of C&D waste delivered to the site throughout the year. Generally the waste stream diminishes somewhat during winter because there is not as much construction or demolition occurring. However, the slow months can vary from year to year depending on weather conditions. Some sites saw as much as a 40% drop in their incoming loads of C&D once winter arrived. Smaller sites mentioned they have little activity between January and March. Landfills located in popular vacationing areas also see C&D waste fluctuation as the population fluctuates. The state of the economy can also influence the amount of C&D waste at landfills. When the economy is booming, buildings are being torn down and reconstructed. When the economy is down there is less construction or remodeling activity.

None of the facilities used incoming C&D material as alternative daily cover. The facilities are required to place cover once a month. Typically, on-site soils are used.

3.2.2.3 Delivered Density

Because most of the facilities charge customers by volume, it is difficult for some sites to give an estimate for the waste density. The density of delivered loads varies depending on what materials are in the load. Demolition loads usually have a higher density than construction loads due to the make-up of the materials within the load. Densities range from a low of 125 pounds per cubic yard to a high of 2,000 pounds per cubic yard. An average density is approximately 460 pounds per cubic yard.

3.2.2.4 Gate Rates

Several of the sites charge customers by volume instead of weight. The most common tipping fee for sites that charge by volume is \$8.60 per cubic yard. The tip fees range from a low of \$6.50 per cubic yard to a high of \$9.60 per cubic yard. There were a few sites that charged customers by weight. The tip fees for these facilities range from \$16.00 per ton to \$43.00 per ton.

3.2.2.5 Source Separation Prior to Delivery

Most of the facilities are aware of generators doing source separation prior to bring materials to the landfill. The materials separated out prior to landfill delivery include cardboard, wood, metal, clean concrete (no rebar or dirt), brick, and asphalt. More recovery occurs prior to loads arriving at landfills when the markets for these materials are good. During the bidding process for projects, contractors might consider that they will be recycling a portion of the C&D waste generated, depending on markets available. As noted elsewhere in this report, LEED™ requires that a certain percentage of materials are recycled when constructing or demolishing a building. One facility survey respondent mentioned that they attempted to implement a recovery plan with a contractor that was building a retail store in their service area. The contractor was not interested. The contractor felt they did not have the storage space to house multiple containers for separating the different types of material.

Some of the facilities receive C&D material from transfer stations and/or C&D recycling transfer stations. The C&D recycling transfer stations separate materials prior to sending residue to the landfill. The majority of the residue is comprised of pieces of sheetrock, roofing, and wood. The transfer stations may do some separating prior to loading materials for delivery to a landfill.

One facility manager interviewed mentioned that their high tip fee encourages customers to separate out as much material as possible prior to bringing a load to their landfill. Other managers felt that customers, particularly contractors, are not affected by tipping costs. They are able to pass that cost onto the owner. If recovery was included in the initial bid and the owner was aware of savings due to recovery, it might help increase recovery. Another manager was having issues with customers bringing in unacceptable materials. To help customers understand the waste acceptance procedures, handouts were given to contractors describing acceptable and unacceptable wastes. Unacceptable materials were still ending up at the landfill. To encourage more separation prior to bring material to the landfill, they increased the tipping fee. The loads were still coming in unclean. Next they charged customers a fine and an hourly rate for having to pick through their loads pulling out unacceptable material. This reduced the amount of unacceptable material, but they still receive problem loads.

One facility respondent was aware of a small contractor that places all of the material in one rolloff initially then picks through it at the end of a project to recover some materials. Two survey respondents mentioned they were not aware of any recovery going on at their facility at this time.

3.2.2.6 C&D Waste Recovery

Several of the facilities do some type of recovery on site. All facilities pull out unacceptable materials at the active face (caulk tubes, paint cans, etc.). Most facilities recover other C&D materials by hand or by using a grapple and a magnet (ferrous metals). The C&D materials recovered on site include clean wood and pallets, metal (copper, aluminum, cast iron, and steel), concrete, brick, asphalt, cardboard, and vinyl siding.

Recovered wood is either stockpiled and then sent to a company as a fuel source or chipped on site for mulch. One site refers whole loads of clean wood directly to a nearby wood processing facility. A big issue with pulling out materials is having a market. Some interviewees mentioned they no longer pull wood from the waste stream at their facility because they have no where close to bring it for further processing (fuel or chipped for mulch). Metals are usually stockpiled and hauled to a metal recycling facility. Cardboard is also hauled to recycling facilities. Concrete and brick is usually stockpiled on site. The concrete material that is recovered is from whole loads of concrete that arrive at the site. The facilities do not pick concrete out of mixed loads. Some sites had the equipment to grind concrete; others stockpile concrete and give it to a local company to grind. Some facilities have the ability to grind concrete with rebar, others consider this contaminated and landfill the material. Two sites also separate asphalt separately from concrete. One site has equipment to grind the asphalt and sell it for reuse. Another facility has an asphalt plant located on their property that processes concrete and asphalt. Another facility defers whole loads of clean concrete and asphalt to Barton. One facility also separates vinyl siding and delivers it to a local operation that chips the material for reuse. This same facility deconstructs trailers. This facility's permit allows for storage of up to 15 trailers on site at one time. The trailers are deconstructed and as much material as possible is recovered. Occasionally the metal frames are used to construct fences to collect blown litter along the perimeter of the property.

One facility formerly operated a sorting line for construction materials. This sorting line had separate rolloffs for cardboard, metal, wood, and MSW. Approximately three employees would sort materials. The sorting varied daily depending on material quantities. The sorting line is no longer in operation, but the facility still has all the equipment. Occasionally this facility will sort new construction (without the equipment) for contractors who are required to recycle a portion of the material from a project. The landfill will weigh the materials separated and give quantities to the contractor.

The smaller facilities seem to do less sorting simply because they do not have the manpower and it is not economical based on the volumes of material they receive. One small facility places rolloff containers near the entrance to allow customers to do their own sorting before their tipping fee is established. These rolloffs are for metal and clean wood.

Two facility managers mentioned having to charge MSW rates for C&D material that had copious amounts of unacceptable material. In these instances, they had the customer dump the load off to the side where an employee could pick out the unacceptable material and send the waste to the appropriate cell for landfilling.

One facility is currently going through a re-permit process. They are considering a staging area to place waste prior to pushing at the active face. This staging area may provide a place to sort or stockpile separated materials depending on markets. They are also considering a price reduction for incoming whole loads of clean concrete and wood.

Most facilities are aware of local markets for recovered C&D materials. Some landfills serve as a local market accepting full loads of clean wood and concrete (chipping and grinding). The most common local markets are for metal, wood, and concrete. Some contractors have permits to stockpile and grind concrete. One area used crushed concrete around the county as bank stabilization. A few areas had local markets for clean cardboard. One facility had a local market for vinyl siding.

3.2.2.7 Barriers

The main barrier mentioned to recovering more material from the C&D waste stream was economics. Most of the facilities did not have funds to pay an employee to sort out materials from mixed loads. Other barriers include low volumes of material, no end markets for materials, and transportation cost to send material for further processing.

3.2.2.8 Government Role

Most interviewees felt the government could help increase recovery. Below is a list of suggestions discussed during the site visits:

- ◆ Generator based incentives or ordinances to promote separation prior to bringing material to a landfill (ex. preferential bid on jobs). An ordinance could be implemented County or State wide. A County ordinance may divert wastes to neighboring counties without ordinances. A statewide ordinance might cause hardship for rural areas where there are fewer options for disposal. If ordinances were put in place restricting what C&D materials could be landfilled, there would need to be alternative markets for these materials. If there are not economical ways to recover the materials, it could increase illegal dumping.
- ◆ Educate people about available markets
- ◆ Ban new construction from landfills
- ◆ Offer incentives to landfills to recover material on site (exempt tax)
- ◆ Sorting on the job is sometimes not feasible. Usually there is not enough room on job-sites to have a different roll-off for all the different materials for recovery. Also usually one job does not produce enough of one material to effectively/economically recover it. It makes more sense to perform a recovery process on a massive scale, at the landfill. The state could create incentives or sources to fund the building of simple processing systems to enhance recovery.
- ◆ If the price of disposal was high enough, it would be economical to recycle more.

- ◆ Contractors could separate materials more easily before bringing their loads to landfills. It is not as easy to separate at the landfill because the loads are usually mixed.
- ◆ Identify end markets for materials.
- ◆ Subsidize transportation costs for recovered materials
- ◆ Give landfills grants or opportunities to get a grinder or chipper

Other comments about the C&D waste stream are listed below:

- ◆ The state needs to recognize how much material is already recovered.
- ◆ Waste is classified as different things (C&D or MSW) in different counties. When there are two different facilities in neighboring counties, often a hauler will utilize both sites. However, because the waste classification is not uniform among counties, it is difficult to enforce how the material must be disposed and what its classification should be without angering the customer. Haulers get annoyed when they bring material to one landfill and it can be classified as MSW but when they take it to another landfill, sometimes owned by the same company; it is now classified as C&D.
- ◆ Recovery and separation efforts should be done prior to the C&D debris arriving at the landfill. Future rules should emphasize dumpster bans instead of landfill bans.
- ◆ Some separating was done on-site at one facility (for three years). It was believed a market for recycling/recovery could be found because customers would feel it is the right thing to do. Customers were told they could bring materials to the facility and that a portion of it would be recovered and recycled. The tipping fee was a little more expensive to cover recovery effort costs. It turned out that most customers vocally supported the effort, but were not willing to pay for it. In order for this effort to have been effective, the charge would either need to be the same or less than the regular landfill tipping fee.
- ◆ For small landfills, it is not economical to have an employee dedicated to sorting materials.
- ◆ There would be more recovering/recycling of materials from the C&D waste stream if it was more economical.
- ◆ Several materials are recovered from building demolitions (lights, railings, cupboards, furnaces).
- ◆ Currently it is cost effective to landfill material. Requiring contractors to do more separating may drive up the contractor fees.

- ♦ It is important to have a program developed and have proper funds prior to implementing new regulations. Get those that will be affected by new regulations on board in the beginning of the process.

3.2.2.9 Summary

As mentioned earlier, the majority of the materials comprising the waste stream are shingles, sheetrock, wood, and concrete. The other material categories are present in the waste stream but at much smaller percentages. There is seasonal variation in this waste stream because construction/demolition projects are dependent on weather conditions. There is usually less C&D material received during the winter months. The density of the C&D material varies greatly depending on the material within a load; however, an average density is approximately 460 pounds per cubic yard.

Source separation prior to delivery and on-site recovery was inconsistent among the sites visited. It is believed by some respondents that contractors recover as much material as they can to avoid having to pay for it to be landfilled and others thought contractors were not concerned with the disposal cost; they just need to get rid of the material and pass the cost onto customers. Some sites recover material on site while others do not. Generally, the larger sites seemed to have more space to store material and do more recovery. The smaller sites, in more rural areas do little or no recovery. The smaller sites (unlined cells) are more concerned with keeping out unacceptable materials and ensuring the waste is clean (free of MSW).

To increase the recovery of the C&D materials, local and state government could work on developing end markets. The site operators stressed that it is important to focus recovery requirements on generators and contractors prior to the materials arriving at the landfill. If sorting is required at landfills, the government could provide funding for capital and operating costs.

3.2.3 Transfer Station Site Visits and SWMCB Transfer Station Data

Transfer stations are waste facilities that handle all types of solid waste including mixed municipal solid waste (MSW) and C&D materials. Activities range from simple consolidation of smaller loads into larger truck loads, to “dump and pick” manual sorting operations directly on the tipping floor, to full-scale C&D waste processing facilities that utilize specialized conveyors with elevated sorting platforms.

This *Minnesota CD&I Study* focused only on transfer facilities that handle C&D materials. Industrial waste is most often hauled directly from the generator to a landfill or recovery alternative. Therefore, only a fraction of total industrial waste will pass through transfer stations.

Materials most commonly recycled from transfer stations include recyclable concrete, asphalt, ferrous metal, wood, corrugated cardboard, and non-ferrous metals. Material recovered via C&D processing also includes alternative daily cover (ADC) for use at landfill operations and biomass fuels.

Transfer data for this *Study* was obtained through selected site visits, phone interviews, monthly reports to the SWMCB metro counties, and annual reports to the MPCA.

A series of site visits and phone surveys were conducted with selected transfer stations throughout Minnesota. A standard set of questions were asked of the owners/managers of the transfer stations. A copy of the transfer station phone survey questionnaire is included in Appendix L. This transfer station questionnaire was intended to complement the landfill surveys, county monthly reports, and the MPCA annual reports. Therefore, not all of the same questions were posed.

3.2.3.1 Statewide Data from Transfer Stations

The MPCA 2005 and 2006 annual reports reviewed covered 113 transfer stations, with 58 of these reporting some amount of demolition debris (C&D for purposes of this study). (The other 55 facilities handle only MSW or other materials such as industrial waste or recyclables.) Of the transfer stations that handle C&D, 39 are located in Greater Minnesota and 19 are in the seven county metro area.

Thirty (30) of the C&D transfer stations report incoming volume in cubic yards and at least 35 facilities report in tons and likely have truck scales that may be used for metered tipping fees. This analysis used the density of 460 pounds per cubic yard as the standard conversion rate to compare relative facility throughputs. The total tonnage of all materials handled at all transfer stations in 2006 is 3.9 million tons. C&D as reported represents 1.2 million tons, or about 30%. MSW as reported represents 2.6 million tons, or about 67%. Industrial waste represents 38,000 tons, or about 1%. Recyclables received (e.g., metal, paper, plastic, etc.) as reported represent 96,000 tons, or about 2%.

The average reported throughput of C&D in 2006 is 20,000 tons. The reported throughput for transfer stations handling C&D ranges from 2 to over 200,000 tons for 2006.

Eighteen (18) facility owners or managers were interviewed. The estimated, stated recovery rates of C&D materials ranges from 0% to nearly 60%. The average recovery rate is about 18%. The list of materials reported recycled/recovered from C&D waste includes cardboard, metals, plastics, glass, concrete, asphalt, wood, shingles, and gypsum/sheet rock.

3.2.3.2 Metro Area Data from County Monthly Reports

The extended Project Team, including the SWMCB county staff, helped to assemble and analyze the extensive data from metro area transfer stations. Individual county staff were asked to compile the past three years (2004 through 2006) of data as reported by their licensed facilities. Data from the following facilities, by county, were assembled and analyzed.

- ◆ Anoka County
 - ▶ Blaine Environmental Campus LLC Transfer, Circle Pines
 - ▶ BFI – Blaine
 - ▶ Shamrock Disposal C&D Transfer – Blaine
 - ▶ SKB Transfer Station – Blaine

- Waste Management – RE-CY-Co Transfer – Blaine
- ◆ Hennepin County
 - BFI – flying Cloud Transfer Cloud, Eden Prairie
 - Broadway Resource Recovery LLC, Minneapolis
 - Malcolm Avenue Recycling & Transfer (RRT) – Minneapolis
 - Minneapolis Southside Transfer Station – Minneapolis
 - Tubs Recycling and Transfer Facility – Minneapolis
 - Veit Container & Recycling Facility – Minneapolis
 - Waste Management Transfer – Maple Grove
- ◆ Ramsey County
 - Keith Krupenny & Son Disposal Service – St. Paul
 - Ray Anderson & Sons – Dumpster Box Services – St. Paul
 - Red Arrow Waste Disposal – St. Paul
 - Twin City Refuse – St. Paul
 - Veit Disposal Systems STP Recycle Facilities – St. Paul
 - Veolia ES (Vasko) Solid Waste – St. Paul
 - Waste Management Transfer (RRT) – St. Paul

Transfer stations report monthly by type of waste on:

- ◆ Incoming (by county of origin), outbound, and destination (by facility) of solid waste.
- ◆ Special materials (by type of appliances).
- ◆ Recyclables separated at the facility (by material, by county of origin).
- ◆ Recyclables separated prior to arriving at the facility (by material, by county of origin).

Figure 3-6 displays the trends in recovered commodities from metro area transfer stations over the past three years as derived from these SWMCB County monthly reports. There has been a significant increase in the recovery of material used for alternative daily cover (ADC) and concrete. Table 3-6 displays this same trend data in numerical table form.

Figure 3-6 Sum Total of All Metro Area C&D Transfer Stations; Trends in Recovered Commodities

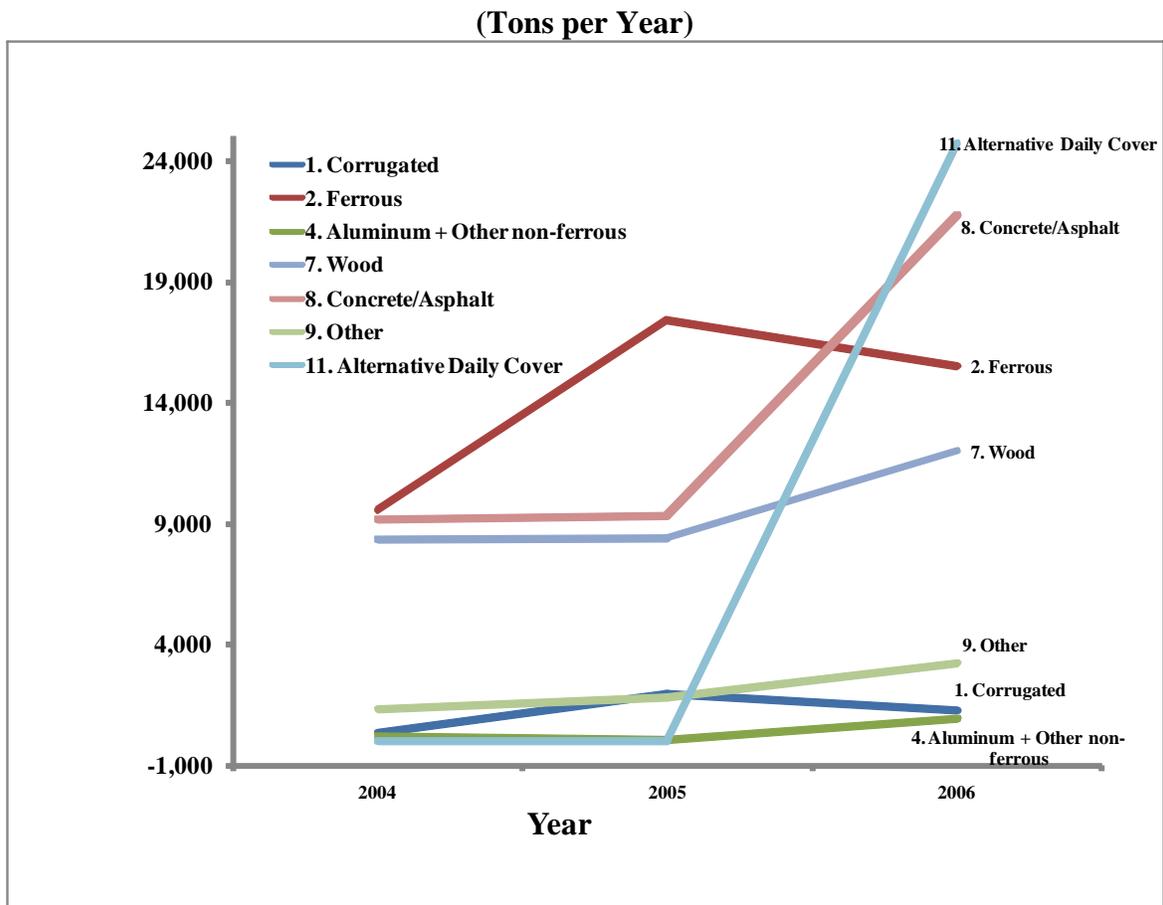


Table 3-6 Sum Total of all Metro Area C&D Transfer Stations: Trends in Recovered Commodities

	2004	2005	2006
Corrugated	368	1,961	1,295
Ferrous	9,556	17,414	15,482
Aluminum + other non-ferrous	213	78	952
Wood	8,314	8,401	12,000
Concrete/asphalt	9,162	9,300	21,725
Other	1,344	1,786	3,227
Alternative daily cover	0	0	24,715
Total tons recycled	28,957	38,940	54,681
Total tons recovered	28,957	38,940	79,396
Total Tons Received	426,576	457,832	430,596
% Recycled	7%	9%	13%
% Recovered	7%	9%	18%

Figure 3-7 displays the total tons recovered per year by individual facility. Table 3-7 displays this same facility specific data in numerical table form.

The two transfer stations that have upgraded their facilities to include materials recovery equipment (crushing, elevated sorting platforms, screens, etc.) are Broadway Resource Recovery (Minneapolis) and Shamrock (Blaine). Once converted to C&D processing facilities, these two facilities have been successful in significantly increasing their recovery. Figure 3-8 displays Broadway's recovery trend over the past three years and Table 3-8 displays this same data in numerical table form. Broadway upgraded their new materials recovery facility to include sorting and processing capacity in May of 2006.

Figure 3-7 Metro Area C&D Transfer Stations: Tons Recovered per Year by Facility

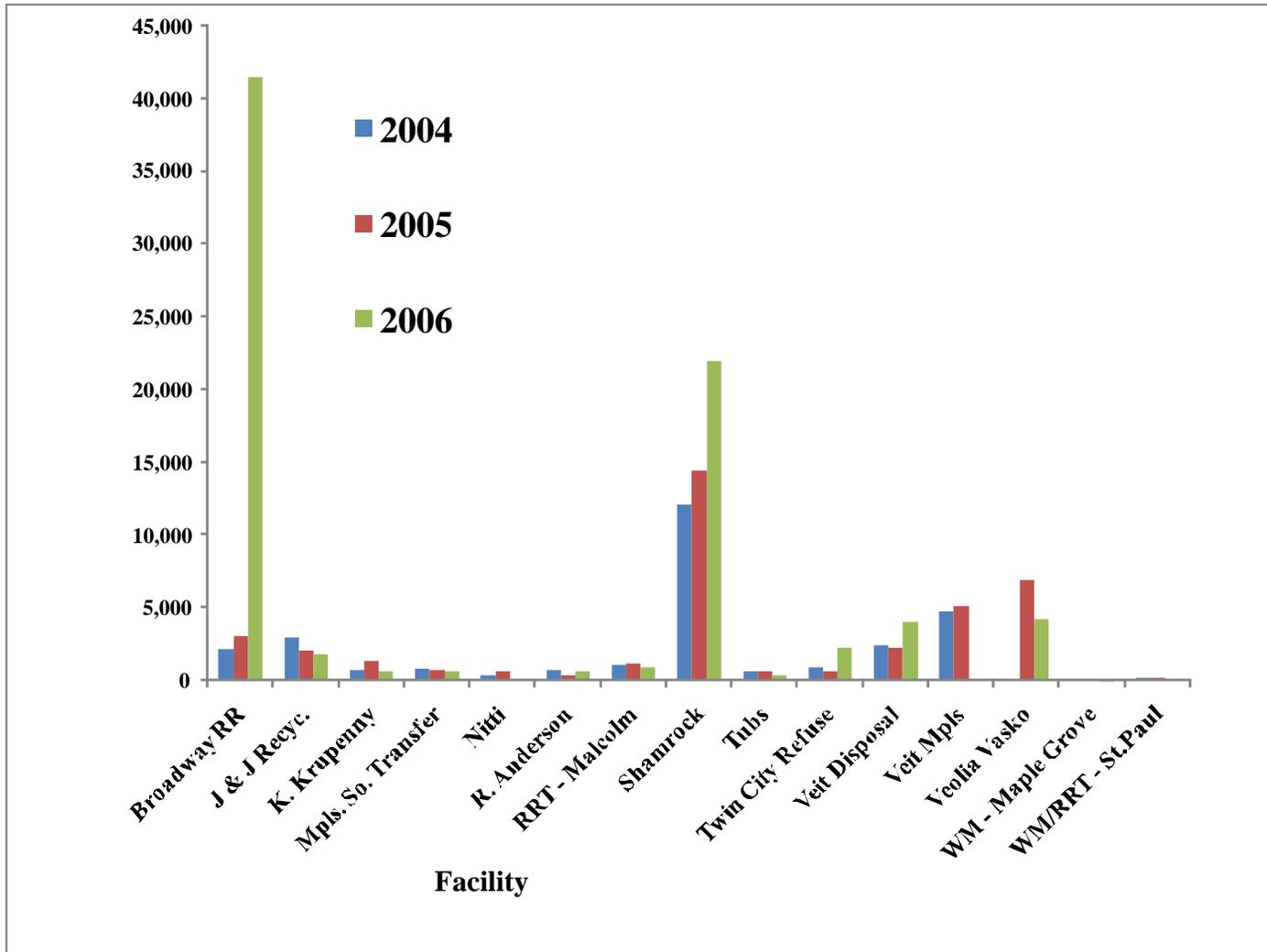


Table 3-7 Metro Area C&D Transfer Stations; Tons Recovered by Year by Facility

	BFI - Blaine	BFI Flying Cloud	Broadway RR	J & J Recyc.	K. Krupenny	Mpls. So. Transfer	Nitti	R. Anderson	Red Arrow	RRT - Malcolm	Shamrock	SKB - Blaine	Tubs	Twin City Refuse	Veit Disposal	Veit Mpls	Veolia Vasko	WM - Maple Grove	WM - Recyco	WM/RRT - St.Paul	TOTAL
2004																					
Total Tons Recovered	0	0	2,069	2,889	664	722	276	644	0	1,007	12,040	0	555	812	2,353	4,700	47	69	0	110	28,957
% Recovered	0%	0%	3%	n.a.		8%		6%	0%	2%	22%		9%	7%	8%	8%	0%	0%	0%	1%	7%
2005																					
Total Tons Recovered	0	0	3,035	2,001	1,264	722	569	352	0	1,101	14,392	0	553	630	2,203	5,032	6,859	54	0	174	38,940
% Recovered	0%	0%	4%	n.a.		8%		4%	0%	2%	26%		9%	7%	7%	9%	16%	0%	0%	1%	9%
2006																					
Total Tons Recovered	0	0	41,423	1,848	667	694	0	676	0	967	21,944	0	383	2,291	4,085	0	4,266	31	0	123	79,396
% Recovered	0%	0%	40%	n.a.	11%	8%		9%	0%	2%	35%	0%	7%	20%	14%		12%	0%	0%	1%	18%

Figure 3-8 Broadway Resource Recovery LLC Trends in Recovered Commodities

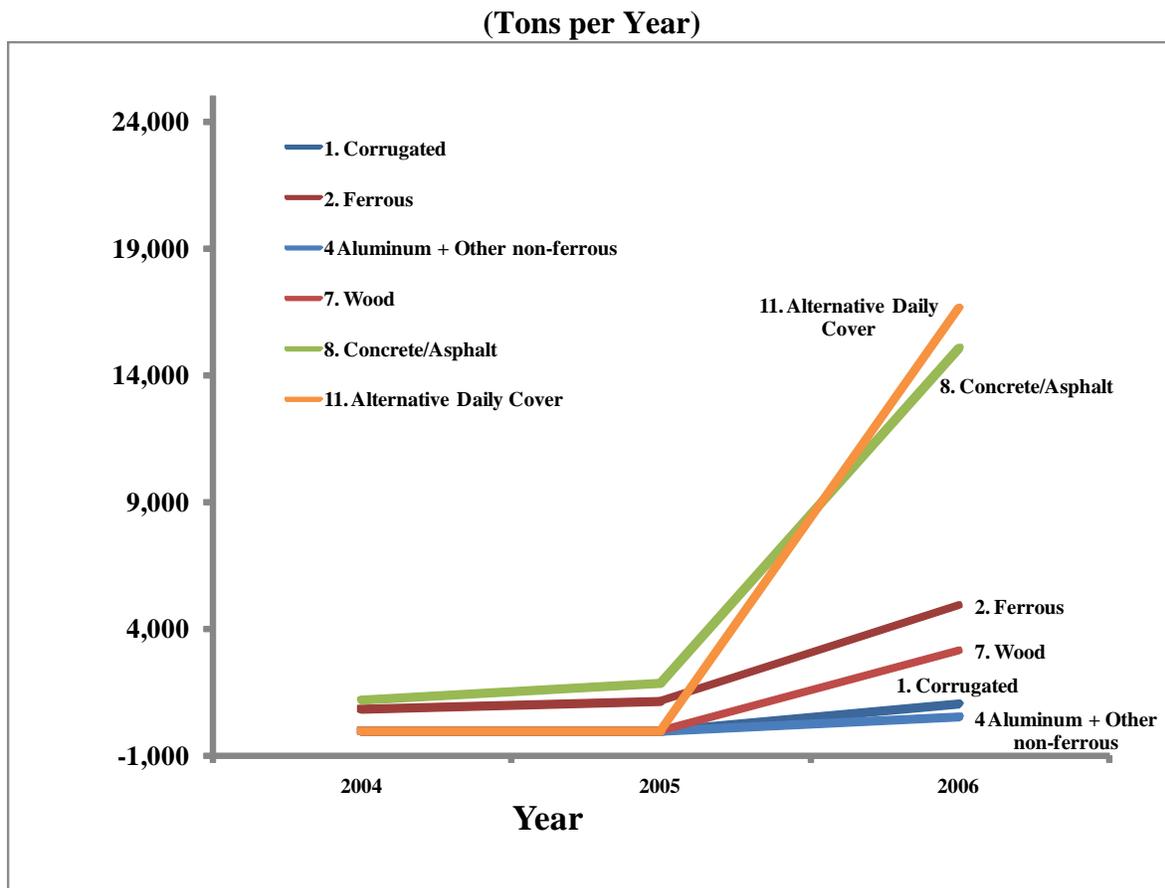


Table 3-8 Broadway Resource Recovery LLC Trends in Recovered Commodities

	2004	2005	2006
Corrugated	0	0	1,037
Ferrous	856	1,160	4,920
Aluminum + other non-ferrous	0	0	563
Wood	0	0	3,156
Concrete/asphalt	1,212	1,875	15,066
Alternative daily cover	0	0	16,681
Total tons recycled	2,069	3,035	24,741
Total tons recovered	2,069	3,035	41,423
Total Tons Received	70,793	80,078	102,567
% Recycled	3%	4%	24%
% Recovered	3%	4%	40%

Figure 3-9 displays Shamrock’s recovery trend over the past three years and Table 3-9 displays this same data in numerical table form. Shamrock upgraded their new materials recovery facility to include sorting and processing capacity in mid 2006.

Figure 3-9 Shamrock Trends in Recovered Materials
(Tons per Year)

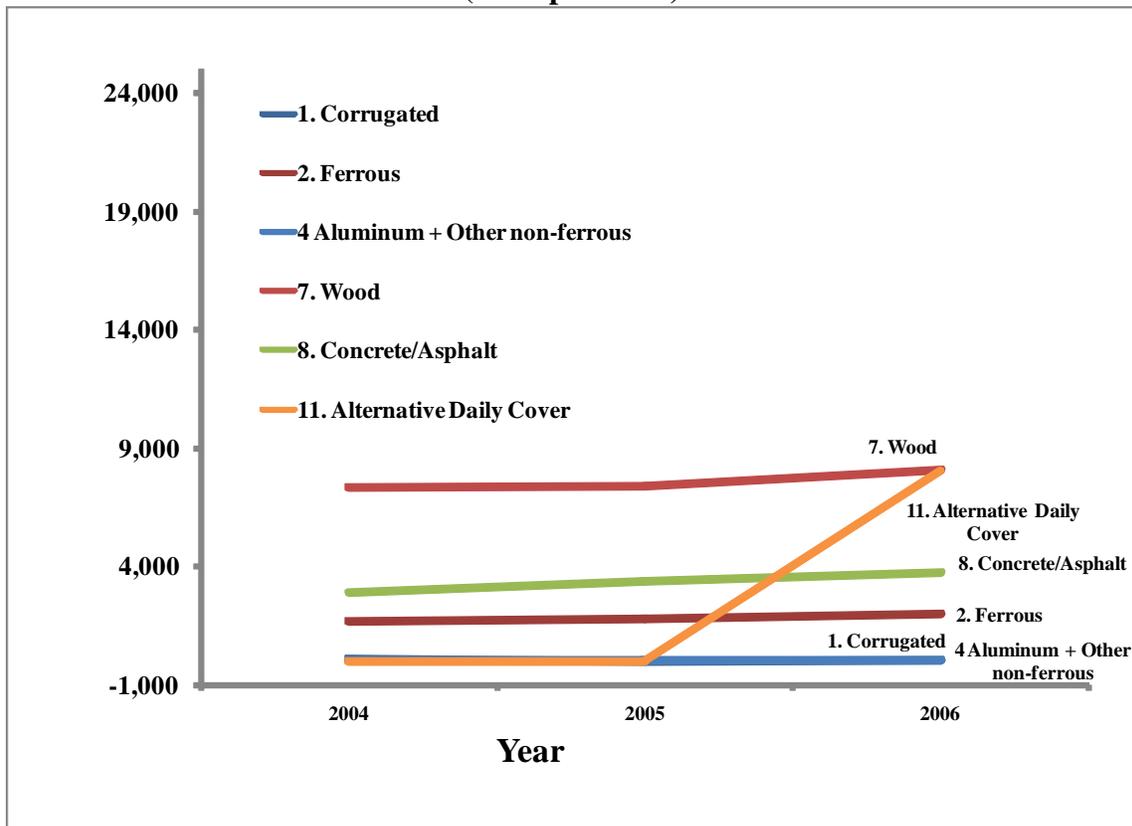


Table 3-9 Shamrock Trends in Recovered Commodities

	2004	2005	2006
Corrugated	90	NA	29
Ferrous	1,654	1,798	2,005
Aluminum + other non-ferrous	30	17	15
Wood	7,352	7,418	8,100
Concrete/asphalt	2,914	3,360	3,761
Alternative daily cover	0	0	8,034
Total tons recycled	12,040	14,392	13,910
Total tons recovered	12,040	14,392	21,944
Total Tons Received	54,039	55,262	63,275
% Recycled	22%	26%	22%
% Recovered	22%	26%	35%

3.2.3.3 Transfer Station Survey Results

The following topics help summarize the results of most of the open-ended responses to the qualitative questions within the interviews.

3.2.3.3.1 Processing

Most transfer station facilities use very simple “dump and pick” methods of manual separation from the tipping floor assisted by loaders and skid steers. Only a very small number of the largest facilities have elevated sort lines assisted with other mechanical sorting/processing equipment. While such larger facilities are more appropriately defined as C&D processors, they are still classified as transfer stations for purposes of MPCA and county reports and this analysis. Other mechanical processing and sorting equipment used at these larger facilities include: size reduction (grinders, hammer mills), magnetic separators, screens (both deck screens and trommel screens). Further processing of recyclable materials often occurs at locations other than the transfer stations (i.e., at intermediate or end markets).

Respondents were asked to describe the list of incoming waste/recyclable materials and outgoing products. In addition, they were encouraged to elaborate on the type of processing (e.g., sorting). A sampling of individual responses includes:

- ◆ We do not separate the plastic that comes in the MSW or C&D (waste streams) as it is not feasible for us. We take in some asphalt on occasion and it goes to the same place as our concrete and that company grinds it up. We take in cars and have been in business for 45 years as a scrap yard. We do not recycle carpet, what we take in goes into the garbage.
- ◆ We pay for the scrap metal that comes in. No charge for OCC, plastic, or glass that comes in separated.
- ◆ All (incoming material) we take in is our own debris. We don't take from out side customers (public or merchant waste). The only exception is our haulers we have as (supply) customers. Mostly of our C&D material is from our own hauling, which is also why our recycling percentage is so high (estimated at 45%). Orphan waste (MSW & Industrial Waste) goes to Hennepin County. Wood goes to (a landscape company). OCC to (a paperboard mill). Metals go to (scrap dealers). We don't get enough volume of plastic or glass to recycle. Concrete and asphalt are crushed in (our) yard for a Class 5 (type of aggregate alternative). (Approximately) 40,000 tons of asphalt and concrete (were processed) in our yard last year. Gypsum and shingles are landfilled. We are sorting out the clean, dry carpet (for recycling).
- ◆ Our average load is 2 cubic yards, mostly from cars and pickups. (Customers) separate the loads themselves; that way we have good control on what ends up in landfills. We only take a small amount of semi or (larger) truck loads.
- ◆ (As a municipal MSW/C&D transfer station) we don't recycle at our facility. (MSW and construction building materials are reloaded separately for trucking to two different landfills.)

3.2.3.3.2 Barriers

In regard to barriers that prevent more recovery, responses include:

- ♦ Do not have barriers at my facility - try to maintain same level of recycling. Always looking for new sites for disposal and recovery of items: For example, I recycle all the gravel that comes off of hot roofing but not shingles. I am definitely always looking for more recycling markets.
- ♦ No problem with the way it is operating right now.
- ♦ Outlets for the products. There are many people that talk about carpets, ceiling tile and drywall but they are not close enough. The market is getting better, but for instance I don't see it as saving the environment to haul recyclables 250 miles away.
- ♦ The cost of labor and fuel.
- ♦ Time right now and developing the (market) network for the sorted materials.
- ♦ Volatile market.
- ♦ Economies of scale. We have a low population and a low commercial and industrial base. In our area, the economy is mostly based on tourism. Also, volatile markets have a huge impact on the recovery. For example, the market for green glass fell last year. We have found that market outlets for C&D waste are either too far away or need the materials in large amounts before they are willing to work with us. This makes it hard for us as we do not generate large amounts of waste to make this viable.
- ♦ MARKETS! Also, costs of testing or identification of hazardous materials asbestos or lead based paint.
- ♦ Recycling must be cost effective. Currently, revenue does not equal cost of sorting/processing for most materials.
- ♦ Lack of adequate end markets.
- ♦ In some cases, the recycling level claims by recyclers and haulers does not match the actual performance.

3.2.3.3.3 Materials with Greatest Potential

Comments on material recovery growth potential include:

- ♦ Shingles and anything that would be construed as biomass (e.g., wood, cardboard, carpeting); everything except for sheetrock and ceiling tile.
- ♦ I think unpainted wood, sheet rock, asphalt shingles and carpeting. This summer I would like to implement a means to separate these materials. At this point, it is getting the infrastructure set up. My interest in recycling these materials is lower disposal costs and

I hate to see it go into the landfill. I have an article on my wall right now that talks about a company in the city that takes clean carpet.

- ◆ Metals and concrete.
- ◆ Wood waste. We also see potential for recycling more cardboard as some still gets thrown into the garbage. We are starting to do more recycling of electronics.
- ◆ Wood has a good potential with biomass plants being close/available to our facility. One such potential biomass market is slowly switching to biomass. I have spent a lot of money to do C&D recycling but it has really paid off. C&D recycling is way more economically feasible along with the savings to landfill space. A company near-by bought a grinder so we now recycle all brush, sawmill waste, pallets etc. I would like to start recycling roofing shingles and gypsum/drywall, but there are too many hurdles for me to take on right now. I would like to see shingles used in sub-base and drywall used in compost.
- ◆ Wood if markets improve.
- ◆ Wood and sheetrock. Maybe roofing, especially after storms.

3.2.3.3.4 Role of State Government

Respondents thought state government should:

- ◆ Help improve the value of the material, especially those items I have to pay a tip fee. Sometimes the costs of tip fees are very high.
- ◆ Provide market facilities for recycling in close proximity to the markets. These facilities should be within the same distance as the landfills; that is the only way it is going to work. Actually I think the state and counties should stay out of it completely and just provide grants and tax incentives.
- ◆ Provide tax incentives and grants for equipment.
- ◆ It would be helpful if the State implemented some type of rebate program. Or maybe mandating recycling. I know lots of states are doing that now. That is the ultimate way to make sure it happens. Or the State could require only a percentage of the total waste received be allowed to be landfilled. For example, say you receive in 1,000 cubic yards per year, the State policy could be that you can then only take 500 cubic yards to landfill. Also, the State should publish a list of market companies on where to bring the separated recyclable materials.
- ◆ To help a company start a business or get it off the ground. To provide funding to help in the construction or start up for recycling companies.
- ◆ The State could increase county “SCORE” grants so that we could expand/invest in more collection roll-offs and semi's trucks to collect C&D wastes.

- ♦ Give us credit on our “SCORE” funding!! Recycling of C&D waste has been grossly neglected. It should have been more strongly encouraged years ago. I think the State and counties are finally on the right track. C&D is easier to recover than MSW. More research on C&D would be a big benefit. I would like to recycle more roofing shingles and drywall. Too many hurdles in the road to get a material to be accepted and recycled.
- ♦ I would like to see the processing credit come back into force that went away a few years ago. Why should the State penalize “front-end” processing facilities? I would like to see the State “SCORE” funding increase. With the SCORE funding going down, it is difficult for small rural counties to find additional money to supplement our recycling facilities. We would like to see our fair share of the inflationary factor put on the SCORE funding.
- ♦ Glass market development, including use as aggregate in road base construction and alternative daily cover at landfills. Need State mandate or counties won’t try it.
- ♦ More productive work on alternative markets such as effective research and development. State policy reports with discussion only don’t help as much as real infrastructure development.
- ♦ Develop a means of certifying actual recycling performance. Require standardized recycling reporting, documentation and independent (government?) verification so that customers and the public can have confidence in the rates of recycling being quoted.

3.2.3.3.5 Role of City and County Government

Suggestions for actions taken by local government were:

- ♦ I don't think cities and counties should be included in market development. I think that the market should be state controlled (managed) only. An equal playing field would make it much easier to compete. For example: Ramsey & Washington counties have a MSW tax as collected on the haulers’ bills to customers that is pretty substantial. We understand the purpose, but it makes it hard for people pay their bills because of the high rates.
- ♦ Give incentives to our customers to separate the C&D materials for recycling: Ideally, our customers could then dispose of source separated materials at our facility for no cost. In turn, we would work closely with our vendors who dispose of our materials to reduce their cost now coming to them as source separated commodities. I think this source separated approach would be more efficient as the materials would not have to go through so many hands before becoming a recyclable commodity.
- ♦ To help with recycling grants and stuff.
- ♦ County recycling requirements. Or, have some sort of discount or lower rates for recycling.

- ◆ Our city and county is doing everything they can. We don't see how they could do a whole lot more.
- ◆ I cannot think of anything that the city or county can do at this time to promote more recycling.
- ◆ Education is the biggest thing.
- ◆ Subsidize recovery of wood (e.g., loan or grant money to determine feasibility).
- ◆ Solidify local markets.

3.2.3.3.6 Summary of Transfer Station Results

Most of the recycling of C&D materials is being handled direct from the construction job site to the end market or intermediate processor. For example, old pavement materials are broken up, crushed and recycled back as aggregate base on the same project or hauled to an intermediate recycler. Similarly, any recyclable concrete from building demolition operations is usually used on site or trucked directly to an intermediate aggregate recycler without going through a C&D transfer station. Therefore, the easily recycled materials have already been removed before the mixed C&D waste is transported to transfer stations.

Some transfer stations include sorting and recovery operations, but most simply aggregate the C&D waste into larger trucks for hauling to landfill. The standard approach for recycling is still the “dump and pick” operations using manual labor, a skid steer, the tipping floor as the sorting surface and multiple roll-off boxes to hold recyclable and waste materials. Recovery rates in the 5%, 10% to 15% range are common for these typical “dump and pick” operations.

Many of the companies that own and operate transfer stations are outgrowths of their commercial hauling business. Often, the transfer station only receives material from the owner/hauler and does not accept “merchant” waste from other haulers.

Two companies in the Twin Cities metro area have made significant investments in their transfer stations to upgrade into the classification of C&D processing facility. Part of their business strategy is to: (1) reduce trucking costs; (2) avoid landfilling costs as much as possible; and (3) market their hauling/recycling services to customers who also want to encourage more recycling from their building/demolition projects. Neither of these two companies own landfills.

These processing facilities have equipment dedicated to crushing, screening, and other mechanical and manual separation utilizing elevated sorting platforms. After installation of the sorting and processing equipment, their annual recovery rates jumped into the 35% to 40% range or higher with individual months over 50%. Given current markets and recovered commodities (including alternative daily cover), monthly recovery rates at such facilities may be as high as 60%.

Both companies have developed markets and regulatory approvals for the use of material from their sorting operations as ADC at landfills in the region. This *Minnesota CD&I Study* has defined such use of C&D material as ADC as “recovery” but not “recycling” as per MPCA

guidance and Minnesota statutes. The primary motivation of the processing facility companies in diverting material into use as ADC is that it avoids the full charges of normal mixed C&D waste tipping fees at landfills.

Transfer stations and processors handling mixed C&D waste have been challenged in breaking even let alone making a profit on recycling. The relatively high cost of facilities, equipment and labor to sort and process the materials into specified commodities is often not equal to the revenue derived from tipping fees plus sale of materials. Landfilling of mixed C&D waste will likely remain the primary means of managing these materials until the relatively modest landfill tipping fees in the State increase. Therefore, landfill tipping fees are the primary indicator of financial feasibility of increased C&D recycling.

However, there are many very feasible and prudent suggestions for increasing the recycling from mixed C&D waste. The ideas coming from the transfer station managers interviewed should be considered in this CD&I study. In summary, the following are highlights of the most frequent and feasible of the suggestions:

- ◆ The State and counties could accelerate their market research and development.
- ◆ The State and counties could increase the financial and technical assistance provided to businesses interested and capable of investing in new recycling ventures.
- ◆ Use of State “SCORE” funds should be increased and/or focused more on C&D recycling activities and local program development.
- ◆ The LEED™ program should be promoted including use by government purchases of construction services of building and road facilities.

Government agencies should examine the problem of “false advertising” of artificially high claims of recycling rates. Standard definitions, reporting forms, and independent certification systems should be developed to address this problem. This may help promote increases in “actual” recycling. One of the strategic objectives will be to leverage and enhance the buying power of agencies and companies that specify construction and demolition projects pursuant to LEED™ standards.

3.3 Composition Study

The intent of this waste composition task was to develop a more thorough characterization of the potentially targeted wastes in the C&D waste stream in the State of Minnesota. The goal is to provide additional waste characterization data that can be used to assist government and private sector interests in developing additional recovery capacity for targeted wastes for the purpose of reuse, recycling, creation of energy, or compost. The CD&I waste streams have not had rigorous composition analyses similar to mixed municipal solid waste (MSW) characterization studies. Past MSW composition studies have been valuable in helping governmental agencies and private companies prioritize investments in recovery opportunities.

The following subsections describe preparations required to conduct a week-long waste sort of C&D wastes; details the required equipment and staffing used in this project; describes the specific procedures used and the daily process; describes the data analysis, results, and observations on the different material types; and finally provides some analysis of the data and comparisons to other data sources.

3.3.1 Preparations

Preparing for the waste sorting activity includes:

- ◆ Site selection;
- ◆ Development of a Sampling Plan that is representative of the C&D wastes brought to the facility;
- ◆ Determination of the specific waste categories into which the C&D wastes would be sorted; and
- ◆ The proposed schedule of days to conduct sorting activity.

As part of development of the proposal to the SWMCB, Foth contacted SKB Environmental, Inc. (SKB) to determine if it would be interested in hosting a waste sorting project for a week-long period. This would entail SKB's assistance of providing data on C&D waste streams for development of the representative sampling plan along with provision of the in-kind use of staff, a loader, generator, and other ancillary equipment. SKB agreed to host the sorting project.

The Project Partners all wanted the composition study results to be as representative as possible of the statewide composition. This is always an issue when the limited budget only allows for conducting limited field work. A site has to be chosen, a time of the year selected, and so forth. All these factors have the potential to affect the results. Foth strived to limit the impact of these factors.

SKB has three different facilities within the nearby service area that receive C&D wastes from numerous different sources. Economic activity in the area includes numerous construction and demolition activities using materials and processes common to the rest of the State of Minnesota (similar construction approaches now and in the past that may currently be demolished, similar recovery processes at generator sites, and so forth). SKB facilities include both lined and unlined landfill cells. Wastes are brought in via direct haul vehicles and transfer trailers from transfer stations that may or may not conduct some separation of targeted materials at the base transfer station. There were no indications that the SKB facilities would be any more or less representative than any other facilities in Minnesota. As part of development of the Sampling Plan, it was decided to conduct portions of the sort at all three of the SKB facilities to make the sample selection as representative as possible of the entire C&D waste stream managed by SKB.

In keeping with typical sorting methodologies, Foth targeted sorting at least 100 different samples from 100 different loads delivered. The target sample weight was 300 pounds. A Sampling Plan was developed by Foth based on a one-year historical review of the origin of

waste loads delivered to the three SKB facilities. SKB provided temporary access to delivery frequency data such that a sampling plan consistent with actual deliveries of Direct Haul Construction, Direct Haul Demolition, Transfer Stations, and pure Roofing loads was developed. The data indicated that 35% of deliveries to SKB facilities come from Direct Haul Construction sources, 27% come from Direct Haul Demolition sources, 35% come from Transfer Stations, and 3% is from Direct Haul Roofing sources. The data allowed Foth to develop a Sampling Plan that targeted loads from hauling companies according to the frequency with which they bring loads to the three different facilities. Exhibit 3-1 shows the final Sampling Plan that was developed. This process ensured that the specific loads targeted for sampling would be as statistically representative of the origin of C&D wastes brought to the SKB facilities as could be done.

It should also be noted that the Sampling Plan (Exhibit 3-1) is broken down between construction waste loads separate from demolition debris loads, separate from transfer loads, and separate from pure roofing loads. The number of loads to be sampled from each is representative of the frequency delivered to SKB. Separately targeting the different sources allows composition information to be developed for the different sources (i.e., composition of construction separate from demolition, etc.) and with the Sampling Plan sample number corresponding to the frequency of deliveries, the combined composition numbers are properly weighted to the frequency of delivery. It was noted that SKB includes remodeling or renovation wastes with their construction deliveries.

Foth prepared a list of draft categories to be sorted and provided the draft list to the Project Partners for review and input. The draft categories were based upon a combination of the targeted categories provided by the SWMCB in the Request for Proposals (RFP) and experience gained by Foth conducting a similar sorting project in the Des Moines, Iowa, area. The final Waste Sorting Categories and Descriptions are provided as Exhibit 3-2 and the Waste Sort Data Sheet is provided as Exhibit 3-3. A total of 21 categories were defined for the sorting process.

C&D waste generation tends to have seasonal variation. Generally construction activity slows down in winter months in Minnesota (December through March). Therefore, Foth sought to complete this task as soon as possible after the contract was completed. The sorting activity was conducted on five consecutive week days starting on November 1, 2006. There was no precipitation on the days of the sorting activity.

Exhibit 3-1 SWMCB C&D Waste Sorting Fall 2006 Sampling Plan

(Page 1 of 2)

Direct Construction

Rosemount Direct Construction					35	
Hauler #	Yards	%	# Samples			
RC	1	109,783	32.5%	11.4	11	
RC	2	27,838	8.3%	2.9	3	
RC	3	24,866	7.4%	2.6	3	
RC	4	24,336	7.2%	2.5	3	
RC	5	20,685	6.1%	2.1	2	
RC	6	10,008	3.0%	1.0	1	
RC	7	8,490	2.5%	0.9	1	
RC	8	8,369	2.5%	0.9	1	
RC	9	7,881	2.3%	0.8	1	
RC	10	7,262	2.2%	0.8	1	
RC	11	7,027	2.1%	0.7	1	
RC	12	6,370	1.9%	0.7	1	
RC	13	5,887	1.7%	0.6	1	
RC	14	4,693	1.4%	0.5		
RC	15	3,533	1.0%	0.4		
RC	16	3,379	1.0%	0.4		
RC	17	1,236	0.4%	0.1		
RC	18	1,095	0.3%	0.1		
RC	19	1,065	0.3%	0.1		
RC	20	6,689	2.0%	0.7		
		290,492	86.1%	30.1		30

Rich Valley Direct Construction						
Hauler #	Yards	%	# Samples			
RVC	1	20,292	6.0%	2.1	2	
RVC	2	9,198	2.7%	1.0	1	
RVC	3	2,415	0.7%	0.3	2	
RVC	4	1,644	0.5%	0.2		
RVC	5	1,397	0.4%	0.1		
RVC	6	1,285	0.4%	0.1		
RVC	7	1,197	0.4%	0.1		
RVC	8	1,165	0.3%	0.1		
RVC	9	8,256	2.4%	0.9		
		46,849	13.9%	4.9		5

Total Yards both = 337,341

Direct Haul Roofing

Rich Valley Direct Haul Roofing					3
Hauler #	Yards	%	# Samples		
RVR	1	14,995	50.5%	1.5	1
RVR	2	4,550	15.3%	0.5	2
RVR	3	3,868	13.0%	0.4	
RVR	4	2,261	7.6%	0.2	
RVR	5	1,103	3.7%	0.1	
RVR	6	960	3.2%	0.1	
RVR	7	1,976	6.7%	0.2	
		29,713	100.0%	3.0	

Rosemount Transfer Hauled

Rosemount Transfer Hauled						35	
Hauler #	cy const	cy demo	Total cy's	%	# Samples		
RT	1	51,215	51,215	15.3%	5.4	5	
RT	2	142,147	80	142,227	42.6%	14.9	15
RT	3	23,462	15,397	38,859	11.6%	4.1	4
RT	4	7,265		7,265	2.2%	0.8	1
RT	5	19,000		19,000	5.7%	2.0	2
RT	6	18,565	11,383	29,948	9.0%	3.1	3
RT	7	44,775	555	45,330	13.6%	4.8	5
Total			333,844	100.0%	35.0	35	

Exhibit 3-1
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Demolition Direct Haul

Rosemount Direct Haul					27
Hauler #	Yards	%	# Samples		
RD 1	17,380	6.6%	1.8	2	
RD 2	5,836	2.2%	0.6	1	
RD 3	4,681	1.8%	0.5	1	
RD 4	3,521	1.3%	0.4	1	
RD 5	3,410	1.3%	0.3		
RD 6	3,363	1.3%	0.3		
RD 7	3,098	1.2%	0.3		
RD 8	2,585	1.0%	0.3		
RD 9	1,982	0.7%	0.2		
RD 10	1,765	0.7%	0.2		
RD 11	1,715	0.6%	0.2		
RD 12	1,715	0.6%	0.2		
RD 13	1,650	0.6%	0.2		
RD 14	1,572	0.6%	0.2		
RD 15	1,489	0.6%	0.2		
RD 16	1,257	0.5%	0.1	3	
RD 17	1,234	0.5%	0.1		
RD 18	1,182	0.4%	0.1		
RD 19	1,032	0.4%	0.1		
RD 20	995	0.4%	0.1		
RD 21	901	0.3%	0.1		
RD 22	900	0.3%	0.1		
RD 23	893	0.3%	0.1		
RD 24	870	0.3%	0.1		
RD 25	830	0.3%	0.1		
RD 26	804	0.3%	0.1		
RD 27	13,860	5.2%	1.4		
	80,520	30.5%	8.2	8	

Rich Valley Direct Haul				
Hauler #	Yards	%	# Samples	
RVD 1	7,830	3.0%	0.8	1
RVD 2	3,800	1.4%	0.4	
RVD 3	3,225	1.2%	0.3	
RVD 4	1,850	0.7%	0.2	
RVD 5	1,722	0.7%	0.2	
RVD 6	1,712	0.6%	0.2	
RVD 7	1,630	0.6%	0.2	3
RVD 8	1,102	0.4%	0.1	
RVD 9	1,053	0.4%	0.1	
RVD 10	1,016	0.4%	0.1	
RVD 11	950	0.4%	0.1	
RVD 12	948	0.4%	0.1	
RVD 13	10,353	3.9%	1.1	
	37,191	14.1%	3.8	4

Dawnway Direct Haul				
Hauler #	Yards	%	# Samples	
DD 1	98,606	37.3%	10.1	10
DD 2	14,352	5.4%	1.5	2
DD 3	7,441	2.8%	0.8	1
DD 4	5,946	2.2%	0.6	1
DD 5	4,859	1.8%	0.5	
DD 6	1,699	0.6%	0.2	
DD 7	1,616	0.6%	0.2	
DD 8	1,299	0.5%	0.1	
DD 9	1,286	0.5%	0.1	1
DD 10	1,199	0.5%	0.1	
DD 11	1,093	0.4%	0.1	
DD 12	1,028	0.4%	0.1	
DD 13	6,239	2.4%	0.6	
	146,663	55.5%	15.0	15

Total Demolition Direct Haul = 264,374

Exhibit 3-2 SWMCB C&D Waste Sorting Categories and Descriptions – Fall 2006

Paper

- ◆ Corrugated/brown paper – Any non-coated corrugated cardboard or kraft paper
- ◆ Paper & other fibers – All other paper, ceiling tile, insulation (not fiber glass)

Plastic

- ◆ Marketable Plastics – Film plastic, HDPE containers (unless badly contaminated), PET containers
- ◆ Other plastics – All other plastics

Metal

- ◆ Ferrous scrap – Anything magnetic including tin, sheet metal, scrap, metal furniture, etc.
- ◆ Non-ferrous – All other metals

Glass

- ◆ Glass – Any glass container, window, etc.

Yard Waste

- ◆ Yard waste – Grass, leaves, and garden wastes

Electric Wastes

- ◆ Electric appliance wastes – Anything with an electric cord or battery powered

Textiles/Carpets/Rubber

- ◆ Textiles, Carpets, & Rubber – Carpet, clothing, drapes, foam rubber, other rubber, etc.

Concrete

- ◆ Concrete items (side walk, blocks, asphalt, etc). Note rebar content.

Wood

- ◆ Non-treated wood – Dimensional lumber, pallets, etc.
- ◆ Tree wastes (stumps, logs, branches, etc.)
- ◆ Green-treated Wood – Any obviously treated dimensional lumber meant for outdoor use (CCA materials)
- ◆ Other Woods – Any and all other wood such as plywood, particle board, painted wood, wood furniture, composite furniture

Bricks and ceramics

- ◆ Bricks – Various bricks, ceramics, etc.

Sheetrock

- ◆ Sheetrock and wallboard – From both construction and demolition

Roofing

- ◆ Roofing – Shingles, rolled roofing, sheathing, roof tear offs, may have some metal and wood contaminants

Miscellaneous Inorganic

- ◆ Misc. Inorganic – dirt, fines, sod, land clearing, and any miscellaneous inorganic materials such as some insulations

Unused Product/Hazardous Materials

- ◆ Containers that still have building adhesives, solvents, paints, caulks, etc. Anything obviously toxic or potentially hazardous. Also include mercury switches or other hazardous wastes. Make a notation on the data sheet to document the material to be clarified as necessary.

Incidental/Other

- ◆ Miscellaneous – Items that just do not fit in the above categories. Make a notation associated with the weights for further clarification.

Exhibit 3-3 SWMCB C&D Waste Sort Data Sheet

Location - Rosemount Rich Valley Dawnway	Sample # _____	Date _____
Waste Type - Const. Demo Transfer Roofing	Recorder _____	Time _____
Hauler _____	Comments _____	

Components	Weights					Recoverability Comment
	1	2	3	4	5	
Paper	Paper					
Corrugated/brown paper						
Other paper						
Plastic	Plastic					
Marketable Plastics						
Other plastics						
Metal	Metal					
Ferrous scrap						
Non-ferrous						
Glass	Glass					
Glass						
Yard Waste	Yard Waste					
Yard Waste						
Textiles/Carpets	Textiles/Carpets					
Textiles and Carpets						
Electric Wastes	Electric Wastes					
Electric wastes						
Wood	Wood					
Tree waste						
Non-treated wood						
Green-treated wood						
Other woods						
Concrete	Concrete					
Concrete						
Brick	Brick					
Brick						
Sheetrock	Sheetrock					
Sheetrock and wallboard						
Roofing	Roofing					
Roofing (incl. Shingles & tear off)						
Miscellaneous Organics	Miscellaneous Organics					
Dirt, incl. misc. inorgan.						
Unused Product/Haz. Wastes	Unused Product/Hazardous Wastes					
Hazardous Wastes, etc.						
Incidental/Other	Incidental/Other					
Miscellaneous						
Comment on Material						

Notes _____

3.3.2 Equipment and Staffing

Exhibit 3-4 provides a listing of the equipment used during the sorting process. The use or need for the various items is self explanatory. It is critical to have a digital scale with quick read out to speed the weighing process for sorted materials. The actual sorting table locations at the SKB sites allowed the loader operator to move sorted wastes back to the working face without the need for the roll-off container.

The Foth sorting crew consisted of four staff for the full week with an additional person the first day to help orient staff to the sorting process. SKB provided the loader operator and an additional staff member to monitor the progress and accuracy against the Sampling Plan and to assist with the sorting process. Four staff members from Dakota and Ramsey County assisted with the sorting process for parts of a day to gain firsthand experience with the types and quality of wastes brought to C&D landfills.

3.3.3 Daily Process and Sampling Plan Consistency

An Operations Plan was developed prior to conducting the sort. The Operations Plan (provided in Appendix M) details the process and procedures to be followed for identifying loads to sample, collecting the sample, sorting and weighing, and various health and safety procedures. Appendix M also has select photos of the sorting process. Foth staff were required to check in at the SKB office each morning prior to traveling to the sorting location adjacent to the landfill working face. Sorting typically started around 7:30 to 8:00 a.m. each day. The first three days, sorting was conducted at SKB's Rosemount facility. The fourth at Rich Valley and the fifth day was at the Dawnway Demolition Landfill.

The actual loads sampled very closely followed the Sampling Plan. A total of 78 loads were sampled at Rosemount with 34 from Direct Haul Construction, 9 from Direct Haul Demolition, and 35 from Transfer Stations. All the targeted sample loads were available at Rosemount. Some extra loads were sampled at Rosemount just in case some loads were not available on the single days spent at the other two facilities. A total of 11 loads were sampled at Rich Valley with 5 from Direct Haul Construction, 3 from Direct Haul Demolition, and 3 from Direct Haul Roofing. A total of 15 Direct Haul Demolition loads were sampled at Dawnway. Over the entire Sampling Plan, only 6 targeted loads were missed and these were replaced with corresponding loads from the extras sampled at Rosemount.

As noted the average sample weight desired was 300.0 pounds per sample. The actual weights ranged from a low of 159.0 pounds to a high of 661.7 pounds. The average sample weight was 355.5 pounds. The average sample weight by source was Direct Haul Construction at 497.5 pounds, Direct Haul Demolition at 386.2 pounds, Transfer Station at 328.2 pounds, and Direct Haul Roofing at 295.5 pounds. While there was some variation in weights, at least 74 samples were between 200 and 300 pounds. Plus, as explained further in the next subsection, it is important to note that for the calculation of percentage compositions, all samples were standardized to 300 pounds prior to calculating targeted material composition percentages.

Exhibit 3-4 SWMCB C&D Waste Composition Field Sorts Equipment Needs

Provided by Foth

Sorting table (4'x 8' sheet of 5/8" plywood with 2"x2" attached to both sides and one end).
Plastic garbage cans for each sorting category
Duct tape to label containers
Heavy black magic marker
Magnet
Digital scale to weigh containers
Digital camera
Leather work gloves
Hardhats
Colored vests
Protective eyewear
Face masks (optional)
Tyvek suits
Long handled push broom
Folding table for scale and paper work
Clipboard and folder
Bottled water

Provided by employee

Workboots (SKB prefers steel shank or toed)
Long pants
Hard hat
Safety vest
Lunches brought to site.

Provided by SKB

Two 55-gallon barrels to support the table
Front-end loader to collect sample with driver
30 cy roll-off container spotted by sorting table (serviced as necessary) or move wastes back to working face with loader)
Radio contact to scale house
Electricity for scale

3.3.4 Data Entry and Tabulation

The weights from all the sorting categories for the samples were entered into a spreadsheet. Each of the samples was standardized to a weight of 300 pounds so that the difference in sample weight from load to load was removed from the composition calculations (weights of heavy samples were reduced on a pro-rated basis to 300 pounds and light samples were increased to 300 pounds on a pro-rated basis). Category weights from each sample are added together with the total divided by the total weight of all the samples from that source. Similarly, the weights from each category and source are added together to get the overall weighted composition percentages for the combined C&D waste stream.

Table 3-10 provides the Summary Results of Field Sorting Data. The table shows the composition percentages separately for Direct Haul Construction, Direct Haul Demolition, Transfer Station, Roofing, and Total combined.

There are some notable differences between the different sources. Construction contains more corrugated cardboard and other paper than Demolition. Transfer Station paper appears to be a blend of Construction and Demolition. Construction contains a significant percentage (8.2%) of Other Plastics while Demolition contains very little plastic overall. Much of the Other Plastics in Construction consisted of vinyl siding remnants.

There is more ferrous metal in Construction loads than Demolition and the Transfer loads contained as much ferrous as the Construction loads. There was more glass in Construction than Demolition, perhaps as a result of the Construction category also included remodeling and renovation wastes at the SKB facilities. There is not much yard waste in any of the sources.

Textiles and carpets were significantly present in the Transfer Station loads (primarily used carpeting). There were not much electric wastes or tree wastes from any sources.

Non-treated wood (dimensional lumber, pallets, etc.) were more prevalent in Transfer loads and Direct Haul Construction than in Direct Haul Demolition. This seems reasonable in that the demolition process may have a tendency to break up lumber into smaller pieces that are no longer recognizable as dimensional lumber making the wood more likely to be sorted into the Other Wood category. Green treated wood made up a relatively small amount of the total wood present. The Other Woods category was very prevalent in each of the sources. Overall, the wood categories made up 22.5% of the composition, the highest of any of the sorting categories.

Concrete and brick was most prevalent in the Direct Haul Demolition making up 18.0% and 10.8%, respectively. This seems consistent in that some of the transfer stations may recover larger chunks of concrete prior to transfer and the percentage of brick in transferred loads may be reduced by the presence of construction wastes.

Table 3-10 Solid Waste Management Coordination Board Fall 2006 Waste Composition
Study Summary Results of Field Sorting Data

Type		Direct Haul Construction	Direct Haul Demolition	Transfer	Roofing	Total Percentage
Paper						
	Corrugated/brown paper	4.1%	1.0%	2.6%	0.0%	2.6%
	Other paper	<u>1.7%</u>	<u>0.7%</u>	<u>2.4%</u>	<u>0.0%</u>	<u>1.6%</u>
	<i>Subtotal PAPER</i>	5.8%	1.7%	5.0%	0.0%	4.2%
Plastic						
	Marketable Plastics	0.5%	0.1%	1.0%	0.0%	0.6%
	Other plastics	<u>8.2%</u>	<u>0.5%</u>	<u>2.1%</u>	<u>0.2%</u>	<u>3.8%</u>
	<i>Subtotal PLASTICS</i>	8.7%	0.7%	3.1%	0.2%	4.3%
Metal						
	Ferrous scrap	3.2%	1.6%	3.4%	2.2%	2.8%
	Non-ferrous	<u>0.3%</u>	<u>0.4%</u>	<u>0.9%</u>	<u>0.0%</u>	<u>0.5%</u>
	<i>Subtotal METAL</i>	3.5%	2.1%	4.3%	2.2%	3.4%
Glass						
	Glass	<u>1.4%</u>	<u>0.4%</u>	<u>0.6%</u>	<u>0.5%</u>	<u>0.8%</u>
	<i>Subtotal GLASS</i>	1.4%	0.4%	0.6%	0.5%	0.8%
Yard Waste						
	Yard waste	<u>0.4%</u>	<u>0.2%</u>	<u>0.1%</u>	<u>0.0%</u>	<u>0.2%</u>
	<i>Subtotal YARD WASTE</i>	0.4%	0.2%	0.1%	0.0%	0.2%
Textiles/Carpets						
	Textiles/Carpets	<u>0.9%</u>	<u>0.3%</u>	<u>9.6%</u>	<u>0.0%</u>	<u>3.7%</u>
	<i>Subtotal Textiles/Carpets</i>	0.9%	0.3%	9.6%	0.0%	3.7%
Electric Wastes						
	Electric Wastes	<u>0.0%</u>	<u>0.0%</u>	<u>0.4%</u>	<u>0.0%</u>	<u>0.1%</u>
	<i>Subtotal E-WASTES</i>	0.0%	0.0%	0.4%	0.0%	0.1%
Wood						
	Tree Wastes	0.0%	0.2%	0.4%	0.0%	0.2%
	Non-treated Wood	3.8%	1.5%	4.3%	0.0%	3.2%
	Green-Treated Wood	0.4%	0.7%	1.2%	0.0%	0.8%
	Other Woods	<u>13.0%</u>	<u>21.4%</u>	<u>22.7%</u>	<u>0.6%</u>	<u>18.3%</u>
	<i>Subtotal WOOD</i>	17.2%	23.9%	28.6%	0.6%	22.5%
Concrete						
	Concrete	<u>8.4%</u>	<u>18.0%</u>	<u>5.3%</u>	<u>0.0%</u>	<u>9.7%</u>
	<i>Subtotal CONCRETE</i>	8.4%	18.0%	5.3%	0.0%	9.7%
Brick						
	Brick	<u>2.9%</u>	<u>10.8%</u>	<u>4.8%</u>	<u>0.0%</u>	<u>5.6%</u>
	<i>Subtotal BRICK</i>	2.9%	10.8%	4.8%	0.0%	5.6%
Sheetrock						
	Sheetrock and wallboard	<u>22.5%</u>	<u>4.1%</u>	<u>7.5%</u>	<u>0.0%</u>	<u>11.6%</u>
	<i>Subtotal SHEETROCK</i>	22.5%	4.1%	7.5%	0.0%	11.6%
Roofing						
	Roofing (incl. shingles & tear off)	20.7%	6.0%	15.4%	32.6%	15.2%
	Flat roofing	<u>0.0%</u>	<u>0.0%</u>	<u>0.0%</u>	<u>63.9%</u>	<u>1.9%</u>
	<i>Subtotal ROOFING</i>	20.7%	6.0%	15.4%	96.5%	17.1%
Dirt/Fines						
	Dirt/fines	<u>6.6%</u>	<u>31.7%</u>	<u>14.9%</u>	<u>0.0%</u>	<u>16.1%</u>
	<i>Subtotal DIRT/FINES</i>	6.6%	31.7%	14.9%	0.0%	16.1%
Unused Product/Haz Wastes						
	Hazardous Wastes	<u>0.4%</u>	<u>0.1%</u>	<u>0.3%</u>	<u>0.0%</u>	<u>0.3%</u>
	<i>Subtotal HW</i>	0.4%	0.1%	0.3%	0.0%	0.3%
Incidental/Other						
	Miscellaneous	<u>0.7%</u>	<u>0.0%</u>	<u>0.0%</u>	<u>0.0%</u>	<u>0.2%</u>
	<i>Subtotal INCIDENTAL/OTHER</i>	0.7%	0.0%	0.0%	0.0%	0.2%
						100.0%

Sheetrock was very prevalent in Direct Haul Construction (22.5% - the largest sorted category for Direct Haul Construction). Roofing was also very prevalent in Direct Haul Construction (20.7%). This likely includes not only new construction but also asphalt shingle re-roofing after storm damage as these loads are classified as Direct Haul Construction at SKB. There was a high percentage (15.4%) of roofing in the Transfer Station sources as well. The Direct Haul Roofing was obviously primarily roofing (96.5%) although some small amounts of metal and wood could be easily separated. Overall, roofing made up the second highest overall percentage of the sorting categories (15.2% shingles plus 1.9% flat roofing for a total roofing percentage of 17.1%). Staff at SKB noted that they were receiving roofing loads as a result of storm damage in the Northfield and Rogers areas this summer. A potential question may be whether this amount of roofing is typical of summer construction seasons or is higher due to storm damage. Then again, on a year to year basis, there may be storms that cause damage in some location more years than not. Flat roofing consists of a thick layer of Styrofoam (approximately 6 inches) and a layer of fiber board covered by a layer of tar and aggregate. The flat roofing was in a condition that did not lend itself to sorting the layers separately. The different layers were still connected and arrived at the landfill in 3 foot squares.

Dirt and fines made up a very significant percentage (31.7%) of the Direct Haul Demolition. This material primarily consisted of dirt, small pieces of concrete, sheetrock, wood, insulation, glass fragments, and roofing. The material was too small to effectively pick through in the time available. In a mixed waste processing facility, this type of material would be separated by the initial screening process and enter the fines or “unders” conveyor. The percentage of dirt/fines in Direct Haul Construction was much less, 6.6%. Overall, the high percentage of dirt/fines in the Direct Haul Demolition caused dirt/fines to make up 16.1% of the overall composition, the third highest.

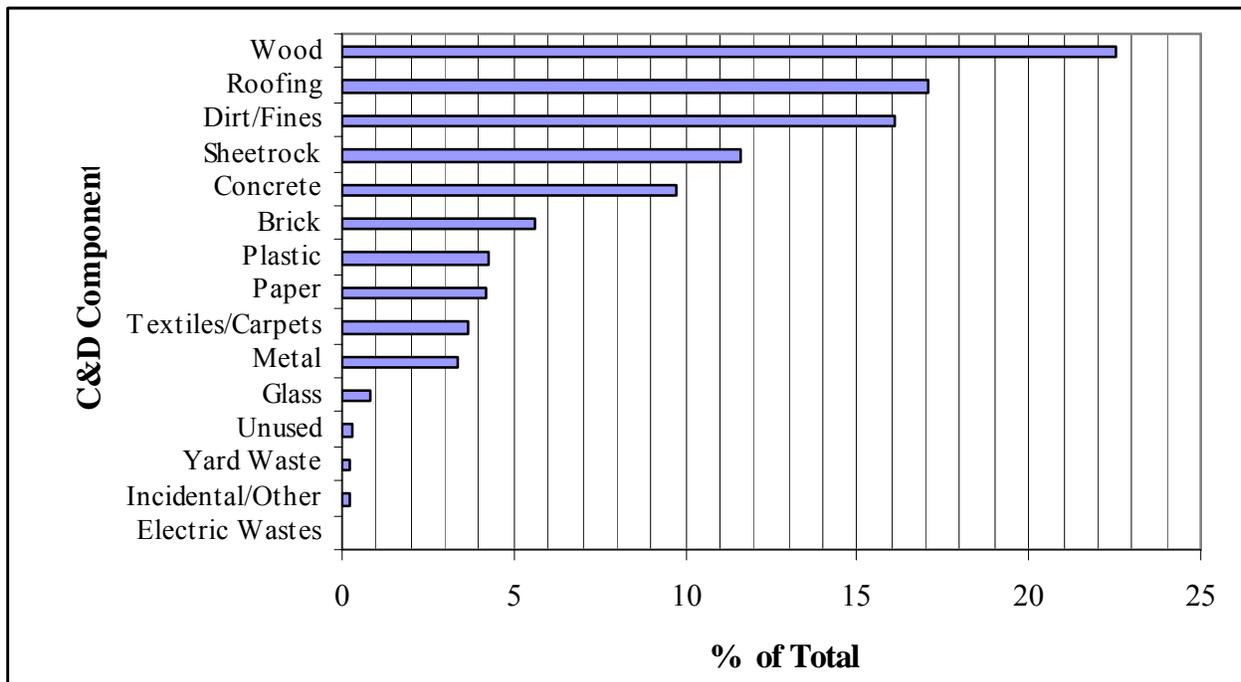
There was very little unused product/hazardous materials and incidental/other materials in any of the sources.

Table 3-11 provides a quick summary of the most to least prevalent of the sorting categories in the overall C&D waste stream and Figure 3-10 graphically illustrates the data.

Table 3-11 Summary of Most to Least Prevalent Targeted Materials

Category	Composition Percentage
Wood	22.5
Roofing	17.1
Dirt/Fines	16.1
Sheetrock	11.6
Concrete	9.7
Brick	5.6
Plastic	4.3
Paper	4.2
Textiles/Carpet	3.7
Metals	3.4
Glass	0.8
Unused Product/Haz. Materials	0.3
Incidental/Other	0.2
Electric Wastes	0.1

Figure 3-10 Summary of Most to Least Prevalent Targeted Materials



3.3.5 Analysis and Comparisons

It is important to note that not all of a potentially recyclable material category is actually recyclable. As the loads were sorted and weighed, Foth made some notations about the

recoverability of some of the materials. Typically most of the ferrous metals could be recoverable, especially in a mixed waste processing facility equipped with magnetic separation capability. Larger chunks of concrete and brick could be recovered either at the source or in a mixed C&D processing facility and potentially made into an aggregate.

Corrugated cardboard has well established marketability in general and was more prevalent in Construction loads than other sources. Even so, not all of this corrugated cardboard would be recoverable into recycling markets. As noted, Foth made brief notations on recoverability as it was possible in the sorting process. Overall, it appears the corrugated cardboard received from construction sources may range from 50 to 75% recoverable to the typical recycling market.

The amounts of marketable plastics were quite low in all sources. Most of this was film plastic sheets. Many of the notes on recoverability for these materials indicated the sheet was dirty. There are two obvious sources for the sheets to become contaminated – as a result of contact with the rest of the C&D wastes and the handling process and as a result of use in the construction process to shield objects from paint, plaster, etc. Source separation could avoid some of this contamination. Overall, separating marketable plastic out of the mixed C&D streams would result in very little recovery.

Most of the textiles/carpet material consisted of large rolls of carpet and some carpet padding. One sample contained a large roll of rubber that increased the overall percentage for this material. Recoverability of these materials for anything other than a fuel would need to occur as a source separation process.

The non-treated and other wood categories may be considered significantly recoverable. Some wood products arrived at least partially intact as garage doors or window frames. Handled at the source, some of these materials may be reusable. Most of the dimensional lumber was quite short and would be of limited value in construction projects. However, most of the non-treated wood could be suitable for grinding into mulch. All of the non-treated and other wood could be recoverable as a biomass fuel.

When sheetrock and roofing (for the most part – asphalt shingles) were present in the sample, they were the predominant material in the entire sample. Significant amounts of these categories would be recoverable from the C&D wastes if there were markets available.

The dirt/fines found predominantly in Demolition consisted of dirt and smaller pieces of many of the typical categories found in demolition debris. Separating the fines into the categories would be difficult. Nevertheless, this type of material is being separated at some mixed C&D processing facilities, including here in Minnesota, and marketed as an alternative daily cover (ADC) for sanitary landfills.

Table 3-12 provides a comparison of the C&D waste composition results from a study completed in 2002 at Metro Waste Authority's landfill in Des Moines, Iowa. This study was conducted by Foth using a similar process as this study, except the sorting was conducted twice—in July and November. The Des Moines data in Table 3-8 provides the composition percentages for each sort and the combined total. There are some notable differences in the July versus November compositions. The amount of wood wastes, particularly other woods, was higher in November and roofing was lower in November. Comparing the SWMCB data to the Des Moines data shows that the top five material categories are the same for each, including wood, roofing, sheetrock, fines, and concrete/brick, which totaled 82.6% in SWMCB and 78.8% in Des Moines.

C&D waste typically shows a seasonal generation pattern. Figure 3-11 shows the average percentage of annual deliveries by month over a nine-year period as delivered to the SKB facilities. The winter months have less construction and demolition activity, and therefore less C&D wastes are generated. As the construction season picks up, C&D waste generation increases, then gradually decreases in November and December.

3.4 Generator Summary

3.4.1 Home Builders

There has been some history in the Twin Cities metro area for construction waste recovery by the home building industry.

In 2002, SWMCB conducted three construction waste demonstration projects in the Twin Cities metro area. Two of the three projects—Demonstration Project Number 1 and Demonstration Project Number 2—were conducted at Pulte Home development projects in Apple Valley, and Chanhassen, Minnesota. The third project, which was similar in scope and a companion project to Demonstration Project Number 1, was completed at Hans Hagen Homes residential construction sites located in the city of Carver (Carver County). The projects were used to identify barriers and opportunities to recycling C&D waste materials during construction projects (on site) and off site at construction waste processing facilities.

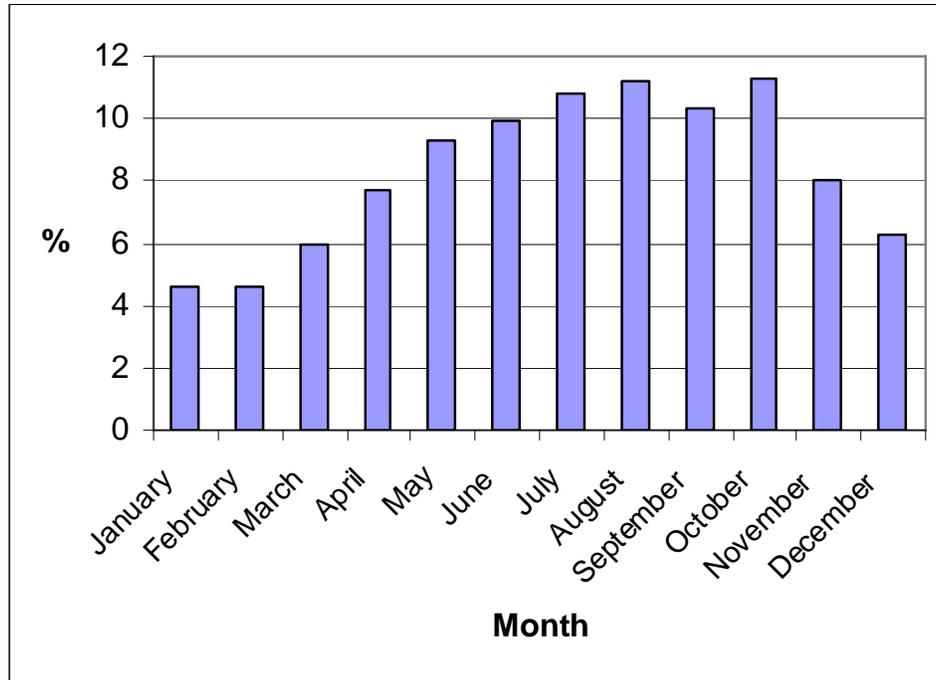
A final report, produced by the URS Corporation and titled *Construction Waste Project*³⁰, evaluated the activities of both Pulte Homes projects and provided text and a table summarizing potential construction waste policy options encouraging future C&D recycling initiatives.

³⁰ *Construction Waste Project Report*, Solid Waste Coordinating Board – Minnesota, December 2002, URS Corporation, URS Job Project Number: 49970-001.

Table 3-12 Solid Waste Management Coordination Board Fall 2006 Waste Composition Study Comparison to MWA Sort 2002 in Des Moines, Iowa (by weight)

Type	SWMCB Sort 2006	MWA Sort 2002		
		July 2002	Nov. 2002	Combined
Paper				
Corrugated/brown paper	2.6%	4.5%	6.0%	5.5%
Other paper	<u>1.6%</u>	<u>0.4%</u>	<u>0.8%</u>	<u>0.6%</u>
<i>Subtotal PAPER</i>	4.2%	4.9%	6.8%	6.1%
Plastic				
Marketable Plastics	0.6%	3.9%	4.3%	0.5%
Other plastics	<u>3.8%</u>	<u>0.4%</u>	<u>0.6%</u>	<u>4.2%</u>
<i>Subtotal PLASTICS</i>	4.3%	4.3%	4.9%	4.7%
Metal				
Ferrous scrap	2.8%	4.0%	3.6%	3.7%
Non-ferrous	<u>0.5%</u>	<u>1.0%</u>	<u>0.8%</u>	<u>0.9%</u>
<i>Subtotal METAL</i>	3.4%	5.0%	4.4%	4.6%
Glass				
Glass	<u>0.8%</u>	<u>0.1%</u>	<u>0.5%</u>	<u>0.3%</u>
<i>Subtotal GLASS</i>	0.8%	0.1%	0.5%	0.3%
Yard Waste				
Yard waste	<u>0.2%</u>	<u>0.3%</u>	<u>0.9%</u>	<u>0.7%</u>
<i>Subtotal YARD WASTE</i>	0.2%	0.3%	0.9%	0.7%
Textiles/Carpets				
Textiles/Carpets	<u>3.7%</u>	<u>1.7%</u>	<u>2.0%</u>	<u>1.9%</u>
<i>Subtotal Textiles/Carpets</i>	3.7%	1.7%	2.0%	1.9%
Electric Wastes				
Electric Wastes	<u>0.1%</u>	<u>2.6%</u>	<u>1.4%</u>	<u>1.9%</u>
<i>Subtotal E-WASTES</i>	0.1%	2.6%	1.4%	1.9%
Wood				
Tree Wastes	0.2%	w/ YW	w/ YW	w/ YW
Non-treated Wood	3.2%	9.7%	5.3%	6.9%
Green-Treated Wood	0.8%	w/ Other	w/ Other	w/ Other
Other Woods	<u>18.3%</u>	<u>13.8%</u>	<u>25.3%</u>	<u>22.3%</u>
<i>Subtotal WOOD</i>	22.5%	23.5%	30.6%	29.2%
Concrete				
Concrete	<u>9.7%</u>	<u>8.7%</u>	<u>6.0%</u>	<u>7.0%</u>
<i>Subtotal CONCRETE</i>	9.7%	8.7%	6.0%	7.0%
Brick				
Brick	<u>5.6%</u>	w/ Concrete	w/ Concrete	w/ Concrete
<i>Subtotal BRICK</i>	5.6%	0.0%	0.0%	0.0%
Sheetrock				
Sheetrock and wallboard	<u>11.6%</u>	<u>13.6%</u>	<u>12.1%</u>	<u>12.6%</u>
<i>Subtotal SHEETROCK</i>	11.6%	13.6%	12.1%	12.6%
Roofing				
Roofing (incl. shingles & Flat roofing)	15.2%	27.8%	17.4%	21.2%
	<u>1.9%</u>	w/ Roofing	w/ Roofing	w/ Roofing
<i>Subtotal ROOFING</i>	17.1%	27.8%	17.4%	21.2%
Dirt/Fines				
Dirt/fines	<u>16.1%</u>	<u>5.4%</u>	<u>10.7%</u>	<u>8.8%</u>
<i>Subtotal DIRT/FINES</i>	16.1%	5.4%	10.7%	8.8%
Unused Product/Haz Wastes				
Unused Product/HW	<u>0.3%</u>	<u>1.2%</u>	<u>0.8%</u>	<u>0.9%</u>
<i>Subtotal HW</i>	0.3%	1.2%	0.8%	0.9%
Incidental/Other				
Miscellaneous	<u>0.2%</u>	<u>0.9%</u>	<u>1.5%</u>	<u>0.1%</u>
<i>Subtotal</i>	0.2%	0.9%	1.5%	0.1%
	100.0%	100.0%	100.0%	100.0%

Figure 3-11 Seasonal C&D Variations (% of Total)



The goal of Demonstration Project Number 1 was to evaluate on-site grinding and beneficial reuse of construction waste materials permitted for on-site application. State and local environmental agencies approved certain materials for beneficial reuse for erosion and sediment control and as base material for driveways. Table 3-13 shows specifications for project materials that were collected, ground, and used on site.

Table 3-13 Demonstration Project Number 1: Materials and Grinding Specifications

Material	Use	Grinding Specification
Solid sawn and engineered wood products, including untreated/unpainted plywood and oriented strand board (OSB).	<ul style="list-style-type: none"> ◆ Erosion control ◆ Sediment control ◆ Temporary walkways on job site ◆ Landscape mulch ◆ Temporary splash protection for finished exteriors (i.e. siding, brick) 	Less than 1 square inch particle size.
Brick, cement block and landscape pavers	<ul style="list-style-type: none"> ◆ Driveway subbase 	Less than 1 square inch particle size.
New asphalt shingles	<ul style="list-style-type: none"> ◆ Driveway subbase 	Less than 1 square inch particle size.

SWMCB staff conducted an identical study, to Demonstration Project Number 1, and evaluated on-site recycling opportunities at a Hans Hagen Homes constructed in the city of Carver (Minnesota). Like Demonstration Project Number 1, similar materials were collected, ground and reused on-site to address erosion and stormwater issues. The application of gypsum drywall to the soil was considered at the site based on the soil needs after testing, but was found that it could not be applied at a cost-effective rate. Cardboard was also collected and recycled from the Pulte Homes and Hans Hagen Homes projects.

Both demonstration projects, Pulte Homes and Hans Hagen Homes, found that on-site reuse and recycling of construction waste materials were comparable in costs to previous waste management methods used by both companies.

Demonstration Project Number 2, like Demonstration Project Number 1, sought to identify barriers and opportunities for increased recycling of construction waste. At the time of the report South Metro Sort and Recycle, Inc. (SMS&R) was the only materials recovery facility processing mixed loads of C&D waste in the Twin Cities metro area. SWMCB worked with SMS&R to identify barriers affecting the optimal use of central processing facilities in Minnesota. The SWMCB report details the challenges faced by central processing facilities like SMS&R, but also makes the case for their role in reducing the amount of C&D waste landfilled.

The following is an outline of challenges, benefits, and recommended actions identified in the report, relative to Demonstration Project Number 2.

Possible Barriers

Potential barriers or challenges to the mixed construction waste dump and sort process are the following:

- ◆ Industry pricing inequities
- ◆ Taxation issues
- ◆ End market limitations
- ◆ Lack of construction industry incentive and education

Possible Incentives

Potential benefits to managing construction waste through a dump and sort facility may be the following:

- ◆ Reduced quantities of waste landfilled
- ◆ Reduced toxicity of construction waste inadvertently entering landfills
- ◆ Reduced need to source separate materials on-site prior to delivery at the facility may encourage use of the facility

- ◆ Increased recycling of materials such as metal and cardboard
- ◆ Project may increase awareness and practicality of waste reduction measures

Foth contacted current residential building trade associations in Minnesota to determine their efforts in providing members with information related to the management of construction waste. Informal telephone interviews were conducted with staff members from the Builders Association of Minnesota (BAM), Builders Association of the Twin Cities (BATC), National Association of the Remodeling Industry of Minnesota (NARI MN), the Green Institute, and Habitat for Humanity of Minnesota.

Initial contact was made with the Builders Association of Minnesota (BAM), an umbrella organization that educates and informs home builders and works on statewide issues, to determine if the association was promoting waste reduction and recycling initiatives. According to BAM staff member, the association is not currently working to develop guidelines or standards addressing waste reduction or recycling of building materials. BAM is in support of the Green Remodeling and Green Homes Program standards being developed collaboratively by the Builders Association of the Twin Cities (BATC), the National Association of the Remodeling Industry of Minnesota (NARI MN), and the Green Institute. The first phase of the Green Remodeling and Green Homes Program is anticipated to be completed in 2007 and target single-family home construction and remodeling projects. Waste management will be one area the standards will address and provide guidelines for reducing construction and remodeling waste, materials reuse, and recycling. The program will be voluntary, but will include a verification protocol and green certification process for participating builders and remodelers. Phase two will expand the program and include standards targeted toward multi-family and planned-unit-development projects. The project team is pushing for 25% adoption of the program by Minnesota home builders and remodelers by 2012.

Foth contacted representatives from BATC, NARI MN, and the Green Institute to obtain information on projects where waste reduction, reuse, or recycling was currently being implemented. Two Twin Cities companies—Morr Construction Services (Morr) and Otogawa-Anschel Design Build (Otogawa)—were identified as companies currently incorporating waste reduction, reuse, recycling, and other green building practices into their current business operations. Phone interviews were conducted with the owner of Morr; and the principal owner of Otogawa and Green Remodeling Program Team Leader.

Morr has managed project waste materials differently since participating in a LEED™ for Homes® project in 2006. By contracting with a company like Atomic Waste, who provides jobsite containers and recycling services to contractors via their processing facility at Broadway Resource Recovery, Morr has been able to recycle as much as 70% of project waste materials. On renovation projects Morr also works with the ReUse Center to divert reusable materials like windows, doors, cabinets, trim, and other items of value.

The ReUse Center is a 26,000 square-foot resale store, launched in 1995 as an organization under the Green Institute. The ReUse Center sells donated and salvaged building materials back to the public at a discounted price. Reportedly, customers generally receive a 75% discount on

products typically purchased from large-box retail home building supply stores. In 1997, the ReUse Center created DeConstruction Services to provide training and employment opportunities for community members. Deconstruction Services crews salvage materials from buildings slated for demolition. The salvaged materials are sold to the ReUse Center, which in turn sells them to the public. To date, over 35,000 tons of construction materials like wood flooring, kitchen cabinets, doors, windows, sinks, tubs, and hardware have been placed back into service. These programs benefit the neighborhood, but they also benefit the greater Minneapolis area by salvaging materials that would otherwise be landfilled. In 2007, the ReUse Center received the 2006 Governor's Award for Excellence in Waste and Pollution Prevention.

Otogawa is a design-build firm that specializes in remodeling older homes in the Minneapolis/St. Paul area and incorporating green building principles into each project. On remodeling projects, Otogawa separates materials like clean lumber and cardboard from other project materials, which are then collected by a hauling company and sorted for recyclable materials at a local MRF. Otogawa also uses waste reduction practices such as advanced framing techniques, which reduces the amount of lumber used on each project by 5% to 10%. The company's Green Materials and Practices Guidelines is provided in Appendix N.

At the time Foth contacted Morr and Otogawa, no projects were available for conducting on-site visits and viewing green building and resource management practices. For contractors and remodelers in northern climates, November through February is typically the slowest period due to extreme weather conditions.

The Habitat for Humanity of Minnesota, Inc. (HFH-MN) is a support organization created under the umbrella of Habitat for Humanity International. As a support organization, HFH-MN was created to identify and serve the needs of the 35 Habitat affiliates in Minnesota as they pursue the creation of decent, safe, affordable housing for those in need. According to Jan Plimpton, HFH-MN Executive Director, Habitat affiliates are on schedule to construct 140 habitat homes throughout Minnesota in 2007.

The construction manager for the Twin Cities Habitat for Humanity (TCHFH), stated TCHFH builds homes using sustainable development practices or green building methods to lessen the impact on the natural environment and reduce the amount of waste landfilled. Waste reduction and recycling are incorporated into all stages of construction of a habitat home. Some of the waste reduction and recycling methods employed by the TCHFH construction team include:

- ◆ **Design stage**
 - ▶ Computer software develops initial house plans with precise measurements to eliminate wasted materials.
 - ▶ Pre-assembled panels are kept at even measurements to make the best use of dry wall materials.
 - ▶ Lumber cutoffs are recycled and used for wall blocking, to which cabinets and towel bars are attached.

- ◆ **Warehouse**

- ▶ Building wall panels at the TCHFH warehouse reduces waste generated at the project site.

- ◆ **Volunteers**

- ▶ Volunteers are asked to recycle cardboard used to package appliances, and any aluminum or plastic products that they bring to the site.
- ▶ Volunteers are asked to “measure twice and cut once” to reduce the amount of cut off waste.

- ◆ **Materials**

- ▶ Blown cellulose, made of recycled paper, is used for insulating homes.
- ▶ Using in-kind donations recycles construction materials that might otherwise have gone to a landfill.
- ▶ Interlocking laminate flooring, which is an engineered product that does not use natural hardwoods, comes in standard lengths to eliminate waste.
- ▶ Cement-board vs. vinyl siding is used whenever possible, as it is easier to recycle.

- ◆ **Waste removal**

- ▶ Waste removal from TCHFH construction sites is handled by Waste Management.
- ▶ Waste Management makes sure all waste is handled properly and cost effectively, and landfilling is the last option.

Habitat Restores are retail outlets where quality used and surplus building materials are sold at a fraction of normal prices. Materials sold by Habitat ReStores are usually donated from building supply stores, contractors, demolition crews, or from individuals who wish to show their support for Habitat. A list of local Habitat for Humanity affiliates is provided in Appendix O

The Winona County Habitat for Humanity ReStore received a \$400,000 grant from the Minnesota Office of Environmental Assistance in June 2003 to purchase a site for the store and become the first Habitat ReStore in Minnesota. The grant was awarded to the Winona ReStore based on the operation’s ability to divert construction materials from landfilling. Since opening in 2003, the operation has diverted over 500 tons of building materials and furniture. Also, since losing its donated building space from the city of Rochester, the Winona ReStore has a cooperative agreement with the Rochester ReStore to share warehouse and retail space.

3.4.2 Demolition Contractors

Demolition contractors comprise a group of specialty services within the construction industry. The profession was originally a simpler site excavating, grading and utilities installation operation. Today, demolition contractors must be diversified into a more comprehensive set of services, which may now also include demolition and recycling; preparation of subgrade and aggregate base; final site-preparation; environmental compliance, and/or other project management services. Some of the contractors market their company to include other services such as: soil remediation, hazardous waste material management, and/or asbestos abatement.

Demolition contractors generally take down residential, commercial, industrial and institutional buildings, but also remove other public works structures such as bridges. There are over 30 companies that list themselves as “demolition contractors” in Minnesota, several are associated with commercial waste hauling (including roll-off services), and a few have their own transfer stations. Many of these serve a multi-state region.

The National Demolition Association (NDA) is a non-profit trade organization serving the United States and Canada that provides educational efforts to help members stay abreast of regulatory and safety matters and keep regulators informed about issues facing their industry. The NDA has identified 14 major constituents of a building structure that could theoretically be recycled. The list includes carpet, drywall, glass, ceiling tiles, wood, asphalt roofing shingles, brick, metal and other constituents. Realistically, there are currently only four—concrete, metal, high-quality lumber, and wood—that have adequate market value. This marketability is highly dependent upon location, competing virgin materials, and end-market demand. NDA estimates that the demolition industry currently recycles approximately 40% of the waste generated on its project sites.^{31, 32}

3.4.2.1 Demolition Contractors’ Interviews and Site Visits

Phone interviews or site visits were conducted to collect additional data about demolition contractors and building demo operations.

What are the most common materials produced from building demolition projects?

- ◆ The most common materials hauled directly from the demo project site for recycling include: concrete and asphalt to be made into recycled aggregate; contaminated soil for remediation; and ferrous for shipment directly to scrap metal dealers.
- ◆ Recyclable concrete that can be used on site as aggregate base saves both on the cost of purchasing new aggregate, plus the costs of trucking to an off-site recycler.
- ◆ Mixed C&D material is the balance of waste material after the recyclables have been source separated.

³¹ “Demolition Contractors Manage and Dispose of Waste Responsibly”(January 2004) by the National Demolition Association, Doylestown, PA. www.demolitionassociation.com.

³² “A Real Incentive: The demolition industry is booming, thanks in part to recycling incentives.” (January/February 2007) by Michael R. Taylor, *Construction & Demolition Recycling* magazine.

- ◆ Asbestos containing material (ACM), items with lead-containing paint, or other contaminated waste are landfilled in facilities permitted for such disposal.

Do you ever re-use or deconstruct items from a demo project?

- ◆ Yes. Occasionally we have old buildings constructed with valuable wood beams and column supports (e.g., Douglas fir). If determined to be salvageable, the resale value of these extra-large, dimensional lumber pieces are factored in to the overall, net project costs to help lower the demolition contractor's bid price.
- ◆ Furniture and any other items "not attached" to the building structure are not included in the scope of demolition services. Therefore, removal, reuse and resale of loose furniture items are generally handled by another subcontractor or waste hauling contract.
- ◆ Rarely can demolition contractors afford to remove attached fixtures (e.g., cupboards, flooring, ceiling fixtures, etc).

How do you determine when waste materials are too contaminated for reuse or recovery?

- ◆ ACM, lead paint, mercury switches and other regulated materials render items into "waste" and, by law, must be disposed and not recycled.
- ◆ Sometimes foundation block is core - filled with vermiculite or foam beads. Vermiculite can be ACM and therefore also renders the concrete block as ACM for regulated disposal.
- ◆ Mixed C&D waste will have a heterogeneous mix of sheetrock, other ceiling material, wood, wiring, carpet, tile, linoleum, other floor coverings, other plastics. Thus the mixed C&D load, in general, must be disposed due to the high cost of labor compared to the avoided tipping fees plus the low value of any such materials, if separated.

What are the typical ranges of recycling rates from demolition projects?

- ◆ It is highly variable and depends on the specific project. It can range, literally, from 0% (e.g., residential homes) to 100% (government owned bridge).
- ◆ 60% is a high-end recycling rate.

What are typical tipping fees or prices for recyclables from demolition projects?

- ◆ Loads of clean, recyclable concrete can generally be tipped for free at aggregate recyclers.

- ◆ Loads of clean, recyclable asphalt can receive a small credit for new hot mix asphalt (HMA) at some plants.
- ◆ Dirty loads of contaminated concrete (with metal or other prohibited materials) are charged a tip fee of about \$100 per load.

What are the key barriers to increasing recycling rates from demolition projects?

- ◆ Additional, economically feasible end markets must be developed.
- ◆ Inconsistent and/or unequal enforcement of environmental and other regulations. “Fly-by-night” operators are alleged to: take compliance short cuts (e.g., ten-day MPCA notice requirements), not fully comply with such regulations (e.g., asbestos abatement requirements), and can often get away with such illegal operations. Often such operators can bid lower than companies that have higher ethical standards.
- ◆ Government “low bid” procedures do not encourage the “best value” approach to service purchasing. Proposer qualifications and waste management innovations should be also considered; not just “lowest bid wins” price policies.
- ◆ Sometimes the environmental regulations appear to be unreasonable. Real environmental and health risks must be assessed whenever possible.

What are the materials currently landfilled with the greatest potential for recovery?

- ◆ Wood (perhaps recovered into a fuel).
- ◆ Sheet rock (need more markets than just an occasional farmer).
- ◆ Roofing material if a market can be established for asphalt shingles.

Do you have any general comments or ideas about how to increase recycling from demolition projects?

- ◆ Government should provide some form of a tax credit to help encourage more recycling.
- ◆ LEED™ is not as directly helpful to the demolition contractor as it is to the general contractor and other companies providing new construction services and products.
- ◆ Recycling mandates should not be imposed. Develop voluntary, market-based incentive approaches first. Need to have end markets and processing infrastructure in place before considering additional stronger recycling requirements.
- ◆ Much of the recycling volumes go unreported. A system should be considered to at least estimate, if not document, the current high rates of recycling at most demolition project sites.

3.4.2.2 Summary of Demolition Contractors

Demolition contractors are playing an increasingly important role in the proper environmental management of C&D materials from building demolition projects. Leaders in the industry are advocating for fair, balanced and uniformly enforced regulations. These same leaders recognize the need for regulations to protect public health and the environment, but want all companies to operate equally under the same rules. The NDA is advocating for a national C&D waste management program to be planned and implemented with industry participation that includes recycling and recovery.

Additional study should look at the need for more intensive data gathering and research on the amounts and types of materials that are currently recycled and recovered from demolition projects in the State. Often, the permits and annual reports to local government and the State do not require recycling documentation. Such a more thorough base of knowledge will help further inform future policy deliberations on how to increase recycling in the future.

It is recognized that more types of large-volume materials may be recycled in the future. The industry generally agrees that wood, asphalt shingles and sheetrock may have good potential for recycling growth in the future if markets are developed. The industry believes the development of such end markets is essential before recycling mandates are considered.

3.5 Salvage, Asphalt, and Concrete Processors

The aggregate, paving, and construction industries are a large segment of our economies using a wide variety of virgin and recycled products. A wide variety of private companies and government agencies are directly involved in the asphalt and concrete production and recycling industries.

- ◆ “End users” include private contractors such as hot mix asphalt and aggregate producers that supplement the traditional virgin materials with the recycled commodities.
- ◆ “Owners” of the road and building facilities may be government agencies or private customers responsible for construction project design and materials specifications.
- ◆ “Demolition contractors” may be the first to handle building demolition rubble such as recyclable concrete or aggregate for direct shipment to intermediate processors.
- ◆ “Processors” (or “aggregate recyclers”) include the contractors (or subcontractors) that receive the raw material, crush/screen, and stockpile the finished recycled product for later shipment or direct installation, on-site, back into the unbound aggregate (gravel) base of the same construction project. Often, these processors are “aggregate producers” manufacturing both virgin and recycled gravel and stone products.
- ◆ “Transfer stations” and other such waste / recycling facilities receive mixed C&D material and may sort and consolidate like commodities for marketing to the processors and/or end users.

Each of these organizations in this materials handling loop can be considered to have an important role in the asphalt and concrete recycling system.

3.5.1 Definitions of Specific Materials, Waste Byproducts, and Recycling Methods

In order to logically analyze the potential for growth in the recycling of asphalt and concrete, it is important to first define and then recognize the existing infrastructures including terminology and interest groups. This report uses the standard terms and definitions as commonly used by Mn/DOT and private contractors in Minnesota. See Appendix P-1 for the list of terms and definitions.

It is instructive to divide the sources of recyclable asphalt and concrete materials into two broad categories: pavement and buildings. Pavement recycling is a mature and well established practice as a general rule. Mn/DOT materials specifications currently allow for both recycled asphalt and concrete pavement to be included as mix supplements back into new aggregate, hot mix asphalt (HMA), and other pavement construction applications for road projects. These pavement recycled materials specifications, in general, are highly engineered with rigorous quality assurance / quality control standards.

Recyclable materials from demolition of buildings are relatively newer commodities used in recycled aggregate. These include items such as: concrete from the building structure (e.g., foundation, walls, floors, ceiling, etc.), brick, concrete and/or asphalt from the site pavement, and asphalt shingles.

3.5.2 Mn/DOT Specifications

Mn/DOT materials specifications for construction of highway construction assisted with state and federal funding have a significant impact on designing the engineering of recycled aggregates. Relevant excerpts of the most recent Mn/DOT specifications can be referenced in Appendix P-2.

Mn/DOT materials specifications for aggregate as road construction base or (“gravel”) surface course imply that building rubble and building brick (i.e., non pavement scrap) are prohibited materials. Mn/DOT specification 3138 - A2 (Aggregate for Surface and Base Courses - Salvaged/Recycled Aggregate Mixtures) states:

“(d) The Engineer may allow aggregate containing a limited quantity of binder soil. However, the composite aggregate mixture/blend shall not contain sod, roots, plants, **building rubble, building brick**, wood, plaster, reinforcing steel or other similar objectionable or deleterious materials and shall be free of lumps or balls of clay.”

Mn/DOT engineers in the Materials Section of the Engineering Services Division were interviewed to further interpret this specification. It was stated that the Mn/DOT specification should be interpreted to define “building rubble” as a more generic category, including mixed building demolition debris. Brick or block that may be made of lower quality concrete may be more problematic than structural building concrete. The intent of Mn/DOT is to move towards

more of a performance-based enforcement of such materials specification for grading and base materials. Thus, if such a change is implemented by Mn/DOT, project engineers may have the authority to allow the use of building concrete or bricks if it is crushed and screened to standard specifications and has no unacceptable materials. However, comments from aggregate recycling contractors indicate that Mn/DOT has recently taken a strict “zero brick” contamination approach to approval of recycled aggregate for use as Class 7 for road base or even common fill in individual road construction projects. At least two road construction projects under construction during this 2007 season have been impacted by the Mn/DOT rejection of Class 7 supplies with visible pieces of brick. Recycled stockpiles and in-place (after installation and compaction) gravel road base have been rejected by Mn/DOT as Class 7 aggregate because of even a fraction of visible contamination from recycled bricks. One aggregate recycler is recommending amendment to Mn/DOT specs to allow a new threshold for incidental amounts (e.g., 3% to 4% or so) of recycled brick in recycled aggregate for road base.

Mn/DOT Office of Road and Materials Research has demonstrated that cold in-place and hot-mix asphalt pavement recycling can be effectively used in road maintenance and construction. According to a study published by the Federal Highway Administration and the Environmental Protection Agency, asphalt pavement is America's most recycled product. The asphalt industry recycles 80.3 million tons of its own product every year, the largest tonnage of any industry. Asphalt pavement enjoys an estimated 80% recycling rate.

Approximately 33% of reclaimed asphalt pavement (RAP) is used in hot mix recycling; 47% is being used for loose aggregate or other reuse application; and less than 20% is being discarded.³³

Mn/DOT specifications to allow the use of RAP has evolved significantly over the past 20 years since research on this recycled commodity first began. Current Mn/DOT specifications for RAP into hot mix asphalt (HMA) allow 20% to 40% RAP depending on the type of road and specific mix design. Mn/DOT's Plant Mixed Asphalt Pavement specifications 2360.2 – A1 (Materials – Aggregate, General), states:

“The aggregate shall consist of sound, durable particles of gravel and sand, crushed stone and sand, or combinations thereof. It shall be **free of objectionable matter such as metal, glass, wood, plastic, brick, rubber, and any other material having similar characteristics**. Coarse aggregate shall be free from coatings of clay and silt to the satisfaction of the Engineer.”

“The Contractor shall not compensate for the lack of fines by adding soil materials such as clay, loam, or silt. Overburden shall not be blended into the asphalt aggregate.”

“Each different material (source, class, kind, or size) shall be fed at a uniform rate from its storage unit. An individual source, class, type, or size of material shall not be stockpile blended with another source, class, type or size of material.”

³³ Asphalt Recycling and Reclaiming Association (ARRA), 2001. Basic Asphalt Recycling Manual.

“Each different material (source, class, kind, or size) shall be fed at a uniform rate from its storage unit. An individual source, class, type, or size of material shall not be stockpile blended with another source, class, type or size of material.”

Mn/DOT’s 2360.2 - A3 [Recycled Asphaltic Pavement Materials (RAP)] specification states:

“The combined RAP and virgin aggregate shall meet the composite fine aggregate angularity or calculated crushed requirements (both coarse and fine aggregate) for the mixture being produced (calculated crushed allowed for Marshall design only). RAP containing any objectionable material, i.e., **road tar, metal, glass, wood, plastic, brick, fabric, or any other objectionable material** having similar characteristics will not be permitted for use in the asphalt pavement mixture.”

Mn/DOT specification 2360.2 – A2h (Plant Mixed Asphalt Pavement, Materials, Aggregate – Scrap Asphalt Shingles) does not allow tear-off (post-consumer) shingle scrap and states:

“Scrap asphalt shingles may be included in both wear and non-wear courses to a maximum of 5% of the total weight of mixture. **Only scrap asphalt shingles from manufacturing waste are suitable.** The percentage of scrap shingles used will be considered part of the maximum allowable RAP percentage (see Table 2360.3-B2a). Refer to Section 2360.2G1 to select a virgin asphalt binder grade (use requirements for > 20% RAP, regardless of total RAP/shingle percentage). Scrap Shingle Specifications are on file in the Bituminous Office.”

In December 2006, Mn/DOT recently amended the asphalt specification 2360.3 (Mixture Design), Table 2360.3-B2a (Mixture Aggregate Requirements) for road pavements with a traffic level 4 (3 to 10 million ESAL’s) or traffic level 5 (10 to 30 million ESAL’s) to state:

“(3) When shingles are included as part of the allowable RAP percentage the ratio of added new asphalt binder to total asphalt binder shall be 70% or greater ((added binder/total binder) x 100 >= 70).”

This additional requirement was recently promulgated to help provide further guidance to contractors on mix design. It has been determined that the effective asphalt value in shingles when added to HMA will supplement the virgin (“new”) asphalt binder. Minimum virgin asphalt binder contents are still needed and now specified in the highest traffic level roads.

3.5.3 MPCA Beneficial Use Determination

3.5.3.1 Concrete

Concrete materials are currently being used widely as replacements for virgin aggregate. A Standing Beneficial Use Determination, Minnesota Rule 7035.2860, has been issued by the Minnesota Pollution Control Agency for concrete when used for aggregate. This determination means that the generator or end user of a material can do so in accordance with this rule without contacting the Agency. According to Minnesota Rule 7035.2860, subp.4, item I, uncontaminated

recognizable concrete, recycled concrete and concrete products, and brick for service can be used as a substitute for virgin aggregate.³⁴

Crushed concrete pavement is often used as a base fill in the construction of roads. The crushed material is used in place of virgin limestone aggregate. This reuse possibility represents a large potential market. This practice is acceptable to Mn/DOT as long as these materials are not from buildings or structures where they are likely to be contaminated.

The economies of scale of such reuse are often dictated by the local availability of limestone deposits, as hauling costs can be substantial. Contamination of concrete with wood, dirt, or other materials can be problematic. Crushed concrete may also be used as primary road surface materials on unpaved roads in rural areas. The use of crushed concrete for driveways is also practiced, with portable crushing equipment available for crushing and grinding directly on-site.

3.5.3.2 Brick Waste

A Standing Beneficial Use Determination, Minnesota Rule 7035.2860, has been issued by the Minnesota Pollution Control Agency for brick when used for aggregate. This determination means that the generator or end user of a material can do so in accordance with this rule without contacting the Agency.

According to Minnesota Rule 7035.2860, subp.4, item I, uncontaminated recognizable concrete, recycled concrete and concrete products, and brick for service can be used as a substitute for virgin aggregate. Brick materials are currently being used widely as replacements for virgin aggregate. This practice is acceptable to Mn/DOT as long as these materials are not from buildings or structures where they are likely to be contaminated. In addition to recycling, brick can be recovered for reuse, which may be of greater value for this waste stream. Brick recycled into an aggregate base for roadbeds and driveways may reduce to clay over time.

3.5.4 Interviews and Surveys – Methods and Results

A series of site visits, phone surveys and an online survey were conducted with selected asphalt and concrete recyclers throughout Minnesota. A standard set of questions were asked of company owners / managers. A web-based, online method of conducting the surveys was originally selected to help ease the distribution, collection and data analyses processes. Phone interviews were also used to supplement the online surveys.

Several trade associations were contacted for assistance in developing and disseminating the asphalt and concrete recycling questionnaires:

- ◆ Minnesota Asphalt Pavement Association (MAPA)
- ◆ Aggregate and Ready Mix Association of Minnesota (ARM)
- ◆ Associated General Contractors of Minnesota (AGC)

³⁴ URS, 2004; “Characterization of Non-Municipal Solid Waste Stream” for the SWMCB.

It was recognized that the credibility and communication channels of these trade associations was essential in helping to maximize the survey response rate in the most cost-effective means possible. Therefore, cover e-mails were sent from the Executive Directors of each trade organization to help promote voluntary, anonymous responses to the customized, online surveys. (See Appendix P-3 to review a copy of the HMA producers' survey instrument.) A coordinated list of companies was maintained to avoid duplicate e-mails of the survey instruments (i.e., if a company is a member of more than one of these trade organizations).

A copy of the MAPA phone survey questionnaire, including cover e-mail, is included in the Appendix P-3. The online survey vendor, SurveyMonkey³⁵, was selected as the most cost-effective alternative for hot mix asphalt (HMA) producers. The option of keeping the responses anonymous was selected to help enhance the confidence of member companies that potentially sensitive or controversial data would not be associated with their name or company. This tactic was intended to help improve the response rates.

To help standardize the written description about this *Minnesota CD&I Study* as part of the introduction page to the SurveyMonkey questionnaires, a fact sheet was produced by the SWMCB and posted on the SWMCB.org web page.³⁶

3.5.4.1 HMA Producers Survey Results

Appendix P-4 contains the detailed survey results of selected MAPA members including both a summary of the quantitative answers and the qualitative, open-ended answers. Together with site visits to a wide variety of HMA plants, the online survey was helpful in documenting the spectrum of recycled materials used, end use applications, blending ratios, processing equipment technologies / procedures, and opinions about the current barriers and opportunities for expanding recycling.

3.5.4.2 Aggregate Producers and Concrete Recyclers

A series of phone interviews or site visits were conducted to a selected sample of aggregate producers and concrete recyclers. Several of the largest concrete recyclers and aggregate producers were intentionally pre-selected.

Final Products (i.e., Outputs):

- ♦ Recycled aggregate for road base and other applications in loose form (i.e., “Class 5”, “Class 6” and “Class 7” aggregate as per Mn/DOT specifications).
- ♦ Virgin crushed stone for road base (Class 5 and Class 6) and other applications.

³⁵ SurveyMonkey.com is an online, web-based software system for designing survey questionnaires, collecting online responses, and automatically tabulating some of the standardized results analyses. (Refer to their web page at www.SurveyMonkey.com for more information.)

³⁶ *Minnesota CD&I Study* fact sheet and project description as posted on the SWMCB.org web page http://www.swmcb.org/files/CDI_Study_Summary_FINAL_3_.pdf.

- ♦ Virgin aggregates for concrete mixes (e.g., ready-mix concrete, pre-cast concrete and concrete block).
- ♦ RAP and virgin aggregate, such as bituminous aggregate, for HMA mixes.
- ♦ Other specialty products including: compost, remediated soil, granular fill, agricultural lime, landscaping stone, bedding materials, rip rap, roofing ballast, roofing mineral aggregate, animal feeds, toothpaste, and other household products.
- ♦ Scrap metal (e.g., rebar) incidental to the recycling of building rubble and other recyclable concrete materials.

Tons per Year:

- ♦ At the high end, 1.5 million to 1.8 million tons of recycled gravel (e.g., Class 5) or RAP in 2006. One estimate of about 80% of the recycled aggregate is used as an unbound gravel base. At the low end, several thousand tons per year.
- ♦ At the high end, 0.5 million to 3.2 million tons of virgin aggregate per year.
- ♦ At the high end 125,000 cubic yards of contaminated soil

Recycling rates:

- ♦ Concrete recycling from buildings 0% - 60%

Salvaged, Reclaimed or Recyclable Materials Used (i.e., Inputs):

- ♦ Concrete pavement.
- ♦ Asphalt pavement.
- ♦ Clean building rubble material (without prohibited contaminants).
- ♦ No bricks or cement blocks (in general).
- ♦ In general, no glass, wood, tires or plastics are recycled by these aggregate companies.

Reclaimed asphalt pavement (RAP) is made from clean chunks or millings of old asphalt roads and other bituminous facilities (e.g., old “blacktop” parking lots). RAP is generally from old asphalt pavement only and generally does not include reclaimed concrete aggregate (RCA) as an additive. Old asphalt pavement chunks or millings are stockpiled separately from other recyclable materials (e.g., concrete pavement, etc.).

It is common practice for aggregate recyclers to use building rubble if it is clean enough **and then** also processed (through additional manual sorting, crushing, screening, and magnetic

separation). In addition to prohibiting contaminants (e.g., asbestos, lead), generally no large items of deleterious nature are accepted. Large pieces of wood, metal, plastics and other non-concrete debris must be removed before the aggregate/concrete recycler will receive for processing.

Materials Ownership:

- ◆ Many of the aggregate recyclers interviewed do not take ownership of the material. Rather, they provide a contract processing service utilizing specialized, mobile recycling “spreads” of equipment.
- ◆ Aggregate, HMA, and concrete producers often own the stockpiles of recyclable materials before processing and own the manufactured recycled product after processing.

Processing Equipment:

Recycled aggregate processing equipment is a fairly mature, evolved technology and generally includes the following system components:

- ◆ Material inspection and acceptance.
- ◆ Two crushers (“jaw” and/or “cone” crushers).
- ◆ Magnetic separators (“overhead belt” and “pulley head” magnets)
- ◆ Deck screens.
- ◆ Loaders, skid steers, conveyors and other typical aggregate handling equipment.

Prices:

In general, the “toll service” aggregate recyclers do not charge a tipping fee or sell the final product because they do not own the stockpiles of incoming or outgoing materials.

- ◆ \$2 to \$5 per finished ton of recycled aggregate product depending on amounts, location, quality and other variables.

If aggregate producers sell recycled aggregate as Class 5 “gravel”, prices at their facilities can range from:

- ◆ \$4 (recycled on the job site) to \$7 per ton (at the central recycling plant)

The equivalent value of material, with cost of trucking to a job site is approximately \$13 to \$14 per ton if a project were required to pay for similar Class 5 from an off site supplier.

What can the State do to help increase recycling?

- ◆ “Mn/DOT’s is doing OK as is.”
- ◆ “MPCA is not doing anything too horrendous at this time. Current regulations (e.g., dust, stormwater) are reasonable.”
- ◆ “Relax the unreasonable restrictions on lead contaminated concrete [in the MPCA beneficial use rule?]. Requirements to shot blast off all lead paint before recycling make recovery of these structures cost-prohibitive.”
- ◆ “Relax the MPCA restrictions on soil contamination when recycling blacktop.”
- ◆ “Develop new, reasonable MPCA standards on diesel-ranged organics (DRO) as a pollutant in contaminated soils. Currently, there are no threshold limits for acceptable levels of DRO’s.
- ◆ Do not legislate recycling requirements before the markets and processing infrastructure are ready (e.g., federal crumb rubber mandate about 15 years ago).

What can local governments (e.g., cities and/or counties) do to help increase recycling?

- ◆ Local politics of siting even a temporary aggregate crushing / recycling operation can be very difficult / impossible to overcome. Sometimes local zoning approvals will kill a project due to perceived nuisance problems (e.g., dust, noise, etc.).
- ◆ Some municipalities require multiple permits for building demolition and recycling projects

What can private companies do to help increase recycling?

- ◆ C&D landfills could increase their tipping fees.

General, miscellaneous comments?

- ◆ Consider establishing drop-off centers for clean, recyclable concrete and asphalt in Greater Minnesota. Such drop-off sites would ideally be located near end-users (aggregate or HMA producers)
- ◆ Some project engineers still specify “virgin only” sources of aggregate (e.g., limestone) thereby prohibiting use of recycled. Some of these prejudices may be carry-over from previous projects with older processing equipment and substandard quality control procedures. This discourages recycling development and can be a significant cost increase to a construction project if on-site, recycled sources of recycled aggregate are available.

- ♦ LEED™ can be an impediment due to the extra monitoring, reporting paperwork and oversight required. Recycling objectives and rate goals must be realistic otherwise the added costs will discourage legitimate contractors and their recyclers from competing. Demolition contractors can't be recycling small quantity items such as bricks, ceiling tiles, etc.

Local permits and state / federal regulations are not a problem for experienced contractors. However, the smaller “fly-by-night” firms will claim they can meet all regulatory requirements at the time of bidding a project but have problems with full compliance during the project execution. For example, full compliance with dust control is an extensive and expensive management/operating expense and short cuts will cause nuisance problems for neighbors and others in the local community.

3.5.5 Summary

Current recycling of asphalt and concrete into aggregate and related road construction products is the largest market outlet for C&D materials. Given the dwindling of natural or “virgin” aggregate reserves, especially in the developed portions of the metro area, recycled aggregates will continue to grow as an important supplement.

Existing materials handling economic and regulatory forces provide the primary incentives for current recycling of aggregate, asphalt and aggregate materials. Additional incentives are coming into the marketplace to help further close the recycling loop. For example, owners are beginning to:

- ♦ Specify the end-of-life recycling requirements for the materials derived from their old facilities at time of demolition and/or reconstruction; and/or
- ♦ Specify the recycled content of aggregate materials used in the construction of their new facility.

Market incentive programs such as LEED™ do not enjoy universal acceptance or understanding. Some contractors view LEED™-type of project specifications as a niche advantage to sell their products and services as a “green” alternative. Other companies consider LEED™ an unnecessary burden that will only serve to increase the cost of demolition and construction projects. Some companies fear that LEED™ monitoring and enforcement is not well developed such that claims may not match actual compliance. For example, LEED™ building “recycling rates” are not well understood, or even always defined, let alone independently certified. Programs such as LEED™ and the alternative standards systems such as the National Association of Home Builders (NAHB) should be explored further and discussed as opportunities to help manage and promote the growth of recycling of C&D materials.

Asphalt and concrete **pavement** recycling is already optimized. This huge source of recycled aggregate already has a very mature infrastructure driven by favorable economics, widespread (if not universal) acceptance in the construction industry, and state recycling specifications/rules that are now have 10 to 15 years of well-documented research and development.

Recycling of similar commodities from mixed C&D debris from **buildings**, however, is much less developed than pavement recycling. According to a literal reading, Mn/DOT specifications still prohibit the use of building rubble, brick, tear-off shingles and other such C&D material for recycling into loose aggregate for road base. Mn/DOT's current specifications may be both a barrier and, via official interpretation or amendment, an opportunity for improving the C&D recycling infrastructure.

MPCA's recent beneficial use determinations (BUD) for concrete, asphalt and shingles may also be a convenient opportunity to work on the next generation of state-guided quality control requirements for C&D debris used in new asphalt and concrete products.

The MAPA members surveyed generally are already using asphalt and concrete pavement. In general, these private contractors optimize the use of recycled pavement materials as a cost saving measure while still maintaining, if not enhancing, final product performance.

Aggregate producers and recyclers interviewed consider the existing government regulatory systems as mostly adequate. Many respondents had no suggestions for change. A few individuals believe that environmental regulations are overly restrictive (e.g., asbestos abatement requirements, lead removal, etc.). Several companies suggested that government enforcement activities of existing regulations are inconsistent (e.g., dust management, safety, etc.).

Some engineers still specify "virgin only" aggregates for construction materials in building and road projects. This type of local policy may be based on the outdated perception that recycled aggregates are generally inferior. If current state-of-the-art, quality control/quality assurance protocols and state and federal materials engineering specifications are employed on an ongoing basis, recycled aggregates can meet the same standards as virgin under specific conditions and applications. There is an opportunity for the State of Minnesota and Minnesota Counties to advocate for continued growth and expansion of the use of recycled aggregates as a matter of policy.

4 Review of Material Markets and Potential Uses

Individual component materials recovered from construction, demolition, or industrial activities can have multiple uses and market values. The available market for any of these recovered materials varies by county and region. For recycling market information specific to a particular county or region of Minnesota, refer to the Minnesota Office of Environmental Assistance (MOEA) online database (<http://www.moea.state.mn.us/market/markets/index.cfm>) of recycling market outlets in Minnesota. C&D Debris is one of twelve market segments listed in the directory. A sub-listing of 13 C&D waste stream materials typically generated during construction and demolition activities are also provided, along with direct links to companies accepting these materials in large commercial quantities.

The market value of CD&I materials ranges from several hundred dollars per ton (e.g., for precious metals) to negative values (e.g., for alternative daily cover). These values are dependent on the typical commodity variables such as:

- ◆ Local market conditions (e.g., landfill tipping fees, presence of end-use consumers);
- ◆ Local and state regulations (e.g., landfill bans, taxes, processing requirements, etc.);
- ◆ Local, state and national materials specifications;
- ◆ Quality of processed material;
- ◆ Quantity available for sale; and
- ◆ Form (e.g., baled vs. loose).

4.1 Asphalt Shingles

4.1.1 Description

Asphalt shingles are the most common type of roofing material used in new home construction and re-roofing projects. Asphalt roofing shingles are a significant portion of a C&D waste stream. The 2006 composition analysis for this *Minnesota CD&I Waste Study* indicated that roofing (including shingles and tear off) made up 15.2% of the total C&D waste sorted (see Table 3-10). Recyclable asphalt shingles are generated as post-industrial (i.e., “manufacturers’ shingle scrap”) and post-consumer primarily from re-roofing projects (i.e., “tear-offs shingle scrap”) and full building demolition projects. In addition, a relatively minor amount of shingle scrap is generated from new building construction, primarily residential homes.

According to the 2004 SWMCB report titled, *Manufacture Shingle Scrap Recycling Project*³⁷, roofing waste is a significant component of the metro's non-municipal solid waste (Non-MSW) waste stream consuming an estimated 20% of area demolition landfill airspace, or 300,000 tons.

Mixed, residential roofing waste is made up of approximately 91% asphalt shingles as measured by other composition analyses of dedicated roofing loads. Such roofing waste is typically delivered to landfills as dedicated loads from roofing companies and their contract haulers, which make residential asphalt shingles ideal for processing and reuse. The large items of

³⁷ Dan Krivit and Associates, *Manufacturer Shingle Scrap Recycling Project, Final Report* for the Solid Waste Management Coordinating Board, August 27, 2004.

plastic, wood, metal and other non-shingle debris are easily sorted for separate recycling or disposal.

Flat roofing sorted as a part of the fall 2006 composition analysis for this *Study* arrived as part of the from the “Direct Haul Roofing” sources (i.e., dedicated loads of roofing trucked directly to the SKB landfill). The number of samples from Direct Haul Roofing loads was proportional to the average of such loads received by SKB (i.e., about 3%). As stated above in Section 3.3.4, the Direct Haul Roofing was obviously primarily roofing (96.5%), although some small amounts of metal and wood could be easily separated. The samples of flat roofing analyzed consisted of a thick layer of Styrofoam (approximately 6 inches) and a layer of fiber board covered by another layer of tar and aggregate. The flat roofing was in a condition that did not lend itself to sorting the layers separately. The different layers were still connected and arrived at the landfill in 3 foot squares.

4.1.2 Potential Uses

There are a number of potential end-uses for asphalt roofing waste including:

- ◆ Hot mix asphalt (HMA);
- ◆ Fuel supplement for cement kilns;
- ◆ Energy recovery in industrial boilers;
- ◆ Aggregate supplement for road base and other construction applications;
- ◆ Aggregate use as a part of new shingles; and
- ◆ Cold mix pavement applications (e.g., repair patch material, etc.).

The use of asphalt shingles in HMA is the most well documented and proven end use application. The other high-value applications (i.e., cement kilns and energy recovery) that utilize the asphaltic, bitumen content are showing strong, but relatively newer promise. Asphalt roofing shingles are approximately 20% to 35% asphalt, while HMA is approximately 6% asphalt, so a small percentage of shingles (5% by weight of aggregate) can displace a large percentage of asphalt binder.

Asphalt shingles are typically ground and screened to produce ½-inch-minus size pieces. The ground shingles are usually fed into the HMA plants along with recycled asphalt pavement (RAP). The SWMCB report noted that hot-mix asphalt producers, utilizing recycled shingle scrap, were saving \$0.50 to \$1.00 per ton of finished product. Pre-consumer shingle scrap has paved the way for future market development opportunities for the 300,000 tons of post-consumer shingle waste currently landfilled in the Twin Cities metro area.

Numerous studies have documented the strong market potential for asphalt shingles in HMA. (Visit www.ShingleRecycling.org for more details.) Minnesota is one of the state leaders in research and development in recycling of asphalt shingles and several of the benchmark studies were conducted here. In 1991, the Minnesota Department of Transportation (Mn/DOT) began investigating whether shingle by-product from the manufacturing process could be used as a beneficial additive to hot-mix asphalt for paving. In 1995, Mn/DOT confirmed that asphalt pavement mix containing shingle by-products performed at least as well or better as those mixes

without shingle by-product and in 1996 adopted its original materials specification allowing the use of manufacturers' shingle scrap in HMA.

Recently, a series of structured research and development projects have been conducted in the Twin Cities metro area that clearly demonstrate the viability of recycling asphalt roofing shingles into HMA used for road pavement. The final shingle-derived HMA product has been tested in numerous controlled field and lab experiments. The high-grade asphalt, the fiber content, and mineral granules contained within the recycled roofing shingles are valuable components of traditional hot-mix asphalt, and the process is economically sound.

4.1.3 Market Opportunities

Currently there are three shingle recycling operations processing manufacturer (pre-consumer) scrap shingles on a regular basis. Manufacturers' shingle scrap is cleaner and more uniform than tear-off (post-consumer) shingles. Plus, manufacturer shingle scrap is available from one single source and therefore quality control of supply is easier for recyclers to manage. Tear-off shingle scrap is sourced from a wider variety of roofing companies and hauler suppliers.

In 2004, URS conducted a related study for the SWMCB: *Characterization of Non-Municipal Solid Waste Stream*³⁸. This earlier SWMCB report summarized that a Standing Beneficial Use Determination has been issued by the Minnesota Pollution Control Agency, Minnesota Rule 7035.2860, for manufacture shingle scrap. This determination means that the generator or end user of a material can do so in accordance with this rule without contacting the agency. Minnesota Rule 7035.2860, subp.4, item Q, allows manufactured shingle scrap and ground tear-off shingle scrap to be used in asphalt pavement or road sub-bases. However, Mn/DOT specifications currently allow only the use of manufactured shingle scrap in hot mix asphalt.

In 2003, Mn/DOT updated its HMA material specifications to allow discretionary use of up to 5% ground shingle scrap from shingle manufacturers for most hot-mix asphalt types. In 2006, Mn/DOT again updated its HMA specification to require a minimum amount of virgin binder in selected mixes using manufacturers shingle scrap.

One of the most important next steps is to continue to work with Mn/DOT on its HMA specification to allow for the use of tear-off shingles. The Mn/DOT specification is the standard used in most asphalt paving designs in Minnesota. Removal of this primary institutional barrier for the use of tear-off shingle scrap may allow the asphalt pavement industry and other private businesses to incorporate the positive economics. The Twin Cities metro area uses approximately 5,000,000 tons of hot-mix asphalt annually.

The SWMCB has a separate, but related ongoing tear-off shingle market development project. Other local, state and federal agencies have other shingle research and development projects underway. Such ongoing efforts will need to be continued for tear-off shingles to overcome questions regarding its long-term performance in highway applications, misperceptions regarding asbestos, and contamination from nails and other debris.

³⁸ URS Corporation, *2004 Characterization of Non-Municipal Solid Waste Stream, Final Report* for the Solid Waste Management Coordinating Board, August 2004, URS Job Project Number: 31809592.00010.

4.2 Metals

4.2.1 Description

Metals recovered from construction or demolition debris typically provide the highest market value of C&D waste stream materials, and are more commonly recovered than disposed. Aluminum, copper (non-ferrous), and steel (ferrous) are the most common metals found in C&D debris.

4.2.2 Potential Uses

Recycled metal is typically remelted and reused in the manufacturing of new products. Due to its strength and durability, structural steel (such as I beams and columns) may be reused in other construction projects or sold as scrap. Even white goods from demolition or deconstruction projects can be sold to scrap dealers, where mercury and CFCs are removed prior to recycling the metal components.

4.2.3 Market Opportunities

These materials are typically accepted at all salvage yards directly from the contractor. If large enough volumes are being generated at a job site, metal recyclers will sometimes site containers for free, or at a minimal cost to cover transportation. The actual market price for metal depends upon several factors: 1) quality of metals collected (ferrous vs. non-ferrous), 2) degree of contamination, 3) ease of separation of mixed metal materials received at salvage yard, and 4) demand for metals in general.

4.3 Old Corrugated Cardboard (OCC)/Paper

4.3.1 Description

Old corrugated cardboard (OCC) is considered a grade of wastepaper and brings more value when separated from other grades of paper. For example, wax coated boxes and boxboards are considered contaminants in a recycling system and reduce the overall value of the recovered material. OCC boxes are made from unbleached, unwaxed paper with a ruffled (corrugated) inner liner. On construction projects cardboard is used primarily as a packaging material, especially at the end of a project when interior fixtures and furniture are delivered to the jobsite, making cardboard an excellent material for separation on-site.

4.3.2 Potential Uses

Most recovered OCC is used as feedstock to manufacture kraft bags, corrugating medium, and boxboard. OCC is being used increasingly in linerboard. Other markets for this material include tissue and toweling, core stock, and bleached board.

4.3.3 Market Opportunities

Building contractors generate used corrugated cardboard from boxes for shipping and storing products such as vinyl siding, hardware, doors, and windows. Composition studies indicate OCC makes up as much as 3% to 6% of the C&D waste stream. Most communities have well

developed cardboard-recycling networks consisting of private and municipal collection facilities. The Minnesota Recycling Markets Directory³⁹ lists 35 companies that accept and process recycled OCC/paper.

4.4 Plastic

4.4.1 Description

Plastic is the most complex component of the C&D waste stream. Many types of plastics are used in building products and construction materials. Some of those plastic products include; *polyvinyl chloride (PVC)* window frames, floors, gutters, siding, pipe and wiring insulation; *polyethylene (PE)* vapor barriers and packaging; *high-density polyethylene (HDPE)* piping, joint compound, paint buckets, and caulk tubes; *polystyrene (PS)* insulation board; *polypropylene (PP)* electrical components; and *nylon* carpet.

4.4.2 Potential Uses

Some of the most recoverable plastics in construction wastes today are vinyl siding, HDPE (buckets), and plastic film (LDPE). Vinyl siding lends itself to recycling because it is made from polyvinyl chloride (PVC) – a thermoplastic that can be repeatedly ground up, re-melted, and formed into a variety of new products⁴⁰. Clean HDPE buckets can be separated and offered for reuse to workers on the jobsite or recycled into a local program. Plastic film is used to protect products delivered to the jobsite and also used as a barrier to protect workers from adverse environmental conditions. Plastic film, like HDPE buckets, can be recycled when kept clean and uncontaminated.

4.4.3 Market Opportunities

Vinyl siding contractors have the best opportunity to recover large amounts of scrap siding from construction projects, similar to drywall contractors that typically manage their own waste scraps from building projects. According to the MPCA's *2005 Report on SCORE Programs*⁴¹, Minnesota's plastic lumber industry has created a local demand for HDPE and prices paid for recovered material are above the national average. The report also indicates there is a strong demand nationally for plastic film for use in plastic lumber. The Minnesota Recycling Markets Directory contains an extensive list of companies throughout the state and region accepting various plastic resins for processing into new products.

4.5 Wood

4.5.1 Description

Wood waste from C&D activities can be classified as it is in Exhibit 3.2 as non-treated wood, green-treated wood, and other woods. Non-treated wood includes dimensional lumber and

³⁹ Minnesota Office of Environmental Assistance, Recycling Markets Directory, <http://www.pca.state.mn.us/oea/market/markets/index.cfm>

⁴⁰ *Vinyl Siding Recycling: A How to Guide*, PlasticResource.com, <http://www.plasticsresource.com>.

⁴¹ Minnesota Pollution Control Agency, *Report on 2005 SCORE Programs*, <http://www.pca.state.mn.us/publications/reports/lrp-p2s-3sy07.pdf>.

includes some pallets. Green-treated wood is a generic term for wood impregnated with chemical preservatives, like CCA (chromated copper arsenate) or creosote pentachlorophenol, which is found in residential construction projects involving decks, fences, or foundations and other applications involving telephone poles and railroad ties. Other wood includes manufactured or “engineered” wood, surface-coated wood, and other items such as wood furniture. Manufactured woods are “engineered”-composite type products held together by glues and binder and generally include plywood, laminated wood, particle board, and oriented strand sheathing. Surface-coated wood is treated to resist moisture or to stain for aesthetic purposes.

4.5.2 Potential Uses

Wood waste generated from construction activities involves off-cuts of solid sawn lumber, engineered wood products, and pallets from material deliveries. These waste materials are either separated at the jobsite or recovered from mixed loads delivered to C&D processors and are typically recovered for end uses like biofuel, mulch, animal bedding, or compost bulking agents. Recycled wood, for use as landscaping mulch or compost, must be free of chemicals, including paint, stain, waterproofing, creosote, pentachlorophenol, petroleum distillates, and pressurizing treatments.

Building demolition projects can generate recoverable wood materials like timbers, trusses, framing lumber, flooring, decking, millwork, doors and cabinets, and window frames, all suitable for reuse or recycling depending on their condition. Recovering these materials through a salvaging or deconstruction process provides the greatest opportunity for their reuse back into the building process and also provides the highest potential market resale value.

Lumber treated with preservatives and lead painted wood are considered hazardous materials in most states. In Minnesota, treated wood is classified as an industrial solid waste and must go into a municipal solid waste landfill⁴².

4.5.3 Market Opportunities

Most recycled clean wood waste is processed and sold locally or regionally to the highest price market. Developing markets for processed C&D wood wastes include landfill cover (ADC), composting, landscape mulch, or biomass fuel. If wood products cannot be salvaged they can be chipped into a feedstock used to create new building materials such as particleboard or medium-density fiberboard (MDF). The specifications for building material feed stock are very stringent since any contamination can affect the final product’s performance and appearance⁴³. One area of great promise for recycled wood is its use in combination with recycled plastics to make useful, high-performance composite products. Minnesota has a well established plastic lumber industry that utilizes waste wood, specifically, Bedford Technologies and Master Mark Plastics, which produce plastic lumber products made from recycled wood and HDPE plastic⁴⁴.

⁴² Good Wood Gone Bad, by Patricia-Anne Tom, Waste Age Magazine, August 2001.

⁴³ Concepts for Reuse and Recycling of Construction and Demolition Waste. US Army Corp of Engineers. Dolan, Patrick J., Richard G. Lampo, and Jacqueline C. Dearborn. USACERL Technical Report 97/58 June 1999.

⁴⁴ Minnesota Pollution Control Agency, *Report on 2005 SCORE Programs*, <http://www.pca.state.mn.us/publications/reports/lrp-p2s-3sy07.pdf>.

Market opportunities for treated wood, especially CCA-treated wood, are limited due to their potential hazardous nature and toxic characteristics. The 2000 Minnesota composition study indicated that treated wood accounted for 3%, or approximately 90,000 tons of MSW landfilled in 1999, and was reported to have increased to 3.5% in 2004, according to the 2004 non-MSW waste characterization study.

Experts currently disagree on whether treated wood, especially CCA-treated wood with arsenic compounds, should be used a fuel source in properly permitted and operated industrial boilers, furnaces, waste-to-energy facilities or incinerators. Results of a 1999 study conducted by the Florida Center for Solid and Hazardous Waste Management⁴⁵ indicated that ash samples from 100% CCA-treated wood exceeded TCLP criteria for arsenic, and also suggested that as much as 5% CCA-treated wood would produce ash samples that would fail a TCLP test. Principals involved in the study believe that CCA-treated wood should be separated out of the C&D wood waste mix prior to incineration.

In the 2005 report titled, *Recycling Waste Treated Wood as Fuel: An Environmentally Responsible Option*⁴⁶, a case is presented for allowing the incineration of treated wood waste in facilities permitted to use the material as an energy source. The report addresses the main issues presented by opponents of beneficial recycling of treated wood by making arguments in favor of incineration.

4.6 Aggregate

4.6.1 Description

Aggregates are among the largest portion of the C&D waste stream, on a weight basis, and are primarily generated from demolition of commercial concrete or brick structures, and from foundations of residential structures. The primary components of aggregate are concrete, brick, ceramics, and miscellaneous fines.

4.6.2 Potential Uses

Concrete can be used in many construction applications and can be found in many forms, which may include⁴⁷:

- ◆ Reinforced concrete, including foundation, structural members, slabs, floor and roof decking.

⁴⁵ Disposal of CCA-treated Wood: An Evaluation of Existing and Alternative Management Options. Principal Investigator, Helena Solo-Gabriele, University of Miami and Tim Townsend, University of Florida. Florida Center for Solid and Hazardous Waste Management. November 1999.

⁴⁶ Recycling Waste Treated Wood as Fuel; An Environmentally Responsible Option. April 2005. Stephen Smith, P.E. Stephen Smith Consulting. Link to report can be found on the Western Wood Preservers Institute website. <http://www.wwpinstitute.org/mainpages/documents/TREATEDWOODFUELRECYCLINGWHITEPAPER.pdf>

⁴⁷ Concepts for Reuse and Recycling of Construction and Demolition Waste. US Army Corp of Engineers. Dolan, Patrick J., Richard G. Lampo, and Jacqueline C. Dearborn. USACERL Technical Report 97/58 June 1999.

- ◆ Precast concrete, includes veneer panels for exterior application, pipe, as well as structural units such as precast sections of decking and structural shapes.
- ◆ Concrete masonry units (CMUs), a block of molded concrete with one or two hollows. The type of aggregate used for CMUs can include sand, stone, gravel, slag, and coal cinders.

Recycling concrete saves on disposal fees for concrete contractors, reduces the expenses of buying new gravel and decreases the cost of making asphalt paving material. A primary challenge in recycling old concrete is breaking the concrete and separating it from its steel reinforcement. Another challenge is to assure that no brick material is included in Mn/DOT's Class 7 aggregate for use as approved road base materials for road construction.

4.6.3 Market Opportunities

Concrete and bricks that are broken or crushed can be used as a low-grade backfill or solid fill material, roadbed aggregate or aggregate for making new CMUs. Aggregate made from recycled concrete can also be used in asphalt paving. Individual aggregate components like concrete, brick, and miscellaneous fines are more valuable when source separated, producing a higher-value end product.

The State of Minnesota has a set of guidelines in using materials as an aggregate into new virgin aggregates. Using recycled materials as a supplement to natural aggregate is not new. Recycled aggregates have been tested and proven successful in several engineering applications by the Minnesota Department of Transportation (Mn/DOT), as well as county and city public works departments; for example, portland cement concrete pavements are commonly recycled and used in place of virgin aggregate as base material. The State of Minnesota uses around 300,000 tons of recycled concrete per year, with a significant portion of it used in road bases.

4.7 Alternative Daily Cover

4.7.1 Description

There are references in other parts of this report regarding the use of processed C&D wastes as alternative daily cover (ADC). MSW landfills are required by rule to cover the solid wastes delivered each day with a suitable cover. Historically, this has been accomplished with the use of at least 6 inches of soil as "daily cover." However, this soil occupies space in the landfill and therefore, landfill operators have consistently sought other measures to meet the purposes for daily cover via a manner that more effectively utilizes the landfill airspace. Thus, ADC approaches have been developed that utilize foams and tarps that essentially meet the purpose of six inches of soil cover without using up airspace.

Another ADC approach is the use of alternative "soil type" materials that do not have other beneficial uses and may even provide a revenue source to the landfill. Materials falling in this category may include materials such as contaminated soils, foundry sands, and other industrial waste by products. Processed C&D waste is included as one of these types of potential ADCs.

4.7.2 Potential Approaches

It should be noted that there are two basic approaches to producing ADC from processed C&D wastes. In one approach previously used extensively in the eastern United States, after recyclable products such as fiber, wood, metals, and aggregates are sorted out of the mixed C&D wastes, the remaining materials are ground up and marketed as an ADC. This approach resulted in the wallboard present in the C&D wastes being ground to small particle sizes. Wallboard is made from gypsum which contains sulfur compounds. Unfortunately, the ground up wallboard when exposed to moisture in an anaerobic environment of a landfill, reacts to form hydrogen sulfide gas. This gas has the odor of “rotten eggs.” Therefore, ADC made from C&D wastes using this approach have been found to cause odor problems at landfills. As a result, landfills have stopped using this product and state regulatory bodies are moving to disallow the ground sheetrock in ADC produced from C&D wastes.

The second basic approach to producing an ADC from C&D wastes is to run all the wastes as delivered through a screen that separates the fines (such as “2 inch minus”) from the remaining C&D wastes. The fines contain a great deal of dirt, dusts, concrete, brick, and other materials that are present as small pieces. The screen “size separates” the C&D wastes and for the most part, the wallboard present in the mixed C&D wastes is carried through the screening process with the rest of the materials. These “fines” are then potentially approved for beneficial use as an ADC. Depending on the mix of demolition versus construction wastes present in the mixed C&D waste stream, the use of these fines as ADC can provide a relatively significant percentage of recovered material. As shown in Table 3-10, during the waste composition work conducted in this project, approximately 16% of C&D wastes were dirt/fines and over 30% of the demolition wastes were dirt/fines.

4.7.3 Market Opportunities

ADC is a beneficial use as without this material, the landfill would need either soil as daily cover or some other method that is less cost-effective. The primary advantage to the C&D processing facility is that they are able to “market” the ADC at a much lower cost than if the materials had to be disposed in a landfill. This helps the overall economic feasibility of mixed C&D waste processing. In Minnesota, ADC from C&D wastes produced via the screening process has been approved by the MPCA from one C&D processing facility. Another facility has apparently been approved to use ground C&D as ADC. This increases concerns related to hydrogen sulfide odors. At the time of this report, the MPCA was re-evaluating the use of C&D based products, both fines and ground, as an ADC.

There is also some concern regarding the total volume of various ADC’s used at a landfill. Other materials besides ADC from C&D fines can be used for alternative cover. MPCA has some concerns that too much material could be taken as ADC for various reasons. Therefore, the MPCA is in the process of developing estimates for the quantity of ADC that may be appropriate annually for each landfill. The outcome of this evaluation will be important for the future of this potential market.

4.8 Biomass Fuel

4.8.1 Description

There is growing interest in the use of portions of the C&D waste stream as a fuel source. There are several categories of materials found in C&D wastes that are combustible with wood being the most prevalent (a total of 22.5% in Table 3-10 of this report). Depending on availability of other markets, some other materials found in C&D wastes could also be recovered as fuel if they are not recovered for other, more cost-effective uses such as recycling. Potential other material categories can include some paper, some plastics, yard wastes (very small amount present), and some textiles/carpets. Based on the composition shown in Table 3-10, a total of over 34% of the wastes could be used as a fuel (excluding green-treated wood). C&D processing facilities in other states have reported a potential biomass fuel percentage of 40% plus or minus.

During development of the report entitled *Analysis of a Biomass/RDF Facility at Rock-Tenn*, Foth obtained a laboratory report on the chemical analysis of the biomass fuel produced at a C&D processing facility in Des Moines, Iowa. According to that laboratory analysis of a sample conducted on February 2, 2006, the Btu content was 6,435 per pound on an “as received basis.”. For that report, Foth also developed an estimate of the Btu content using composition percentages from C&D Waste Composition data from the Des Moines area and Btu values for materials from the *Integrated Solid Waste Management Engineering Principles and Management Issues*⁴⁸. That process resulted in an estimated Btu value of 6,470 per pound (close to the laboratory data point). In addition, Foth obtained additional data from a C&D processing facility in Des Moines in October 2006 that showed the laboratory test data for Btu at 6,940 Btu per pound as received and 7,855 dry. The actual Btu heating value of biomass fuel from C&D wastes will depend on the composition of the fuel and will likely vary somewhat from load-to-load and day-to-day. It appears reasonable to use a range of 6,400 to 6,900 Btu per pound for preliminary planning purposes.

4.8.2 Potential Uses

To produce such a fuel requires either source-separation of the combustible materials at the jobsite or processing of mixed C&D at a mechanical processing facility such as those described in Section 5. After separation, the materials must be ground into a smaller particle size required by a specific solid fuel combustion facility (i.e., meeting the specifications of the facility market).

It should be noted that there could be two basic approaches to recovery of potential fuels from C&D. One approach could focus on dimensional lumber, pallets, tree waste, etc. This biomass fuel may be able to be used in a wider variety of solid fuel combustion processes. However, mulch markets may also compete for this separated wood.

The other approach is to recover the larger amounts of other wood and fibers along with some plastics, etc. This approach would require the combustion market to have controlled combustion

⁴⁸ Tchobanoglous, George, Hilary Theisen, and Samuel Vigil. 1993. *Integrated Solid Waste Management Engineering Principles and Management Issues*. McGraw-Hill Series in Water Resources and Environmental Engineering.

processes and all the proper air pollution control equipment. Thus, markets for such a biomass fuel will be more limited, but if available, could likely use a much larger quantity of fuel from C&D wastes.

4.8.3 Potential Issues

Due to the seasonal variation of C&D waste generation, there will likely be a seasonal variation in the amount of C&D based biomass fuel available with less available in winter months than during the summer months. This may be counter to the potential fuel market seasonal needs.

As noted, some mixed C&D processing facilities that had been producing the ground ADC are attempting to re-design their sorting process to be able to produce a marketable biomass fuel. Fundamental for success will be having markets with the proper combustion controls and air pollution control equipment to properly combust the fuel. Without proper facilities, this form of C&D based biomass fuel will not have a market outlet.

There is some concern that any fuel from C&D waste should not be combusted for energy recovery. For example, one state (New Hampshire) has a moratorium in place on burning wood from C&D wastes; although significant quantities of wood is separated out at C&D facilities and transported to Maine, where it is combusted for energy. Other states simply treat it similarly to other biomass based fuels in that C&D based biomass is required to be combusted in properly designed boilers with appropriate air pollution control systems. It should be noted that C&D wastes have routinely been delivered for many years to the refuse-derived-fuel processing facilities owned by NRG Energy Inc. (now RRT, Inc.) and the resulting fuel has been successfully combusted in the Xcel combustion facilities located in Red Wing and Mankato, Minnesota.

4.8.4 Market Opportunities

There are some biomass fuel based projects currently being considered by project sponsors or markets in Minnesota. For example, two studies have been conducted that consider the use of C&D based biomass fuels at the Rock-Tenn plant located in St. Paul. There are also biomass facilities under consideration by Minnesota Power in northern Minnesota that may be able to use C&D-based biomass, particularly wood.

4.9 Gypsum/Drywall

Gypsum drywall, often referred to as gypsum wallboard or sheet rock, is a major component in the landfilled C&D waste stream. While promising, recycling of this material is still in the development phase, especially for when it is old drywall coming from demolition projects.

Most used gypsum wallboard in Minnesota is still landfilled. Waste reduction can be accomplished by carefully calculating the amount of wallboard needed prior to beginning a construction project and using standard carpentry techniques of “measure twice, cut once.”⁴⁹

⁴⁹ “*Characterization of Non-Municipal Solid Waste Stream*” (2004) by URS for the SWMCB.

Gypsum drywall landfilling has an additional challenge if landfilled. Hydrogen sulfide gas may be produced if the gypsum combines with other waste materials and byproducts in the anaerobic environment of a landfill. (See section 4.7.2 for more discussion on gypsum use within ADC.)

4.9.1 Description

The CMRA web page, www.GypsumRecycling.org has provided an excellent resource on gypsum / drywall recycling. This web page states that gypsum, a naturally occurring mineral, is mined from deposits formed by ancient sea beds. Gypsum is used as a raw material in construction products, as an ingredient in portland cement, and as a soil amendment. The vast majority of gypsum is used in manufacturing of construction products such as drywall.⁵⁰

Gypsum drywall consists of approximately 90% gypsum and 10% paper facing and backing. Drywall comes in many different types and sizes to meet specific construction needs. If clean gypsum can be separated from the sheetrock paper, the majority of the material in the drywall can be recycled. Scrap (post-consumer) gypsum drywall is currently being recycled in several locations in North America. Nonetheless, most drywall in North America is still disposed in landfills. Challenges to more widespread recycling include: costs of collection and separation; low landfill disposal tipping fees; distance to end markets; and market development.⁵¹

4.9.2 Potential Market Applications

4.9.2.1 Manufacture of New Drywall

Many wallboard manufacturers already recycle a portion of their own plant gypsum scrap. If the post-industrial material comes from finished wallboard, the majority of paper must first be removed. Typical ratios of recycled gypsum into new wallboard range from 10% to 20%.⁵²

Several recent case studies have been published describing their recycling of post-consumer drywall from demolition projects. However, recycling of used gypsum wallboard into new drywall is less common than recycling of post-industrial, manufacturers' scrap.

Some manufacturers use synthetic gypsum to make new drywall. Synthetic gypsum is a waste product of the desulfurization of flue gas (air pollution control technology) at coal-fired power plants. This competing source of recycled gypsum, along with the recycling of post-manufacturer scrap, may limit the demand from some drywall manufacturing plants for post-consumer scrap drywall.⁵³

U.S. Gypsum Corporation announced in August 2006 a new gypsum recycling program through its partner, Gypsum Recycling America (GRA), LLC. GRA has begun collecting new gypsum wallboard scrap and used ceiling panels. The first GRA recycling facility was opened in Cambridge, MA in March 2006. The facility is designed to process 60,000 tons of gypsum per

⁵⁰ "What is gypsum drywall" page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

⁵¹ Ibid www.GypsumRecycling.org

⁵² Ibid www.GypsumRecycling.org

⁵³ "Drywall Recycling Market: Manufacture of New Drywall" page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

year. Massachusetts was chosen as the first site because of the State's strong interest in gypsum recycling.⁵⁴

4.9.2.2 Portland Cement Manufacturer

According to CMRA's web page GypsumRecycling.org, "Gypsum is an ingredient in the manufacture of portland cement, added to control the setting time of the concrete. Gypsum is added to the cement clinker from the kiln and the mixture is processed to a fine powder. The typical gypsum content of portland cement ranges from 5% to 10%. Mined gypsum rock is often used by the cement kilns, and the different physical form of processed drywall may necessitate adjustment of the facility's materials handling system. The purity of gypsum in the wallboard is a major concern. Paper should be removed, and care should be taken during the collection of the wallboard to minimize the amount of impurities such as soil that are introduced."⁵⁵

4.9.2.3 Soil Amendment and Plant Nutrient

According to CMRA's web page GypsumRecycling.org, "Gypsum is a common soil amendment and has historically been directly land applied for several different agricultural purposes. Gypsum provides a source of calcium and sulfur for plants; it is commonly applied to peanut crops in the Southeast US as a source of calcium at rates of 600 to 800 pounds per acre. Many vegetables, including potatoes and corn, have been shown to benefit from gypsum application. Unlike lime, gypsum does not raise the pH of soils and it is thus preferred for crops that require calcium but where the soils are already alkaline (and can not accommodate pH adjustment). Gypsum has also been found to be useful for reclaiming very salty soils; the calcium in the gypsum substitutes for the sodium in the soils, allowing the sodium to leach away. Gypsum has the ability to flocculate clayey soils that have drainage problems."⁵⁶

The specifications for gypsum drywall that is applied to soil may differ somewhat from industrial markets. Agricultural applications, in general, can tolerate some ground paper in the mixture. However, other foreign materials such as nails and corner beads must be thoroughly removed. The presence of trace contaminants (such as lead from lead based paint) may need to be more restricted when land applied. Lead content may need to be analyzed by sending a sample to a lab. These lead content levels could then be used if the total lead content is limiting, or prohibiting, the rate of land application.

The land application method will help determine the required recycled gypsum particle size. Standard manure spreaders can be used. Alternatively, the recycled gypsum can be tilled directly into the soil. Some recyclers have marketed bagged gypsum products for soil and plant application. However, the most common application form is to use the recycled gypsum in bulk.⁵⁷

⁵⁴ "USG Recycling Gypsum Scrap and Ceiling Panels" (August 2006) On the National Association of Home Builders' web page: www.nahb.org/news_details.aspx?newsID=3066&print=true

⁵⁵ "Drywall Recycling Market: Portland Cement Manufacture" page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

⁵⁶ "Drywall Recycling Market: Soil Amendment and Plant Nutrient" page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

⁵⁷ "Drywall Recycling Market: Soil Amendment and Plant Nutrient" page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

4.9.2.4 Compost Amendment

Recycled gypsum drywall has been added to composting systems in a number of locations. The paper fraction of the drywall biodegrades and becomes part of the finished organic content of the compost. The gypsum itself is a mineral and will remain as such in the final compost product. This results in a calcium- and sulfur-rich compost, which may have a benefit for some crops as described in the section above.⁵⁸

Gypsum also offers the potential to help mitigate composting odors. Composting odors can be associated with the ammonia gas by-product of the aerobic biological process of the microorganisms. If the composting system is allowed to go anaerobic (without oxygen), the process can release hydrogen sulfide, a foul smelling gas. The application of recycled gypsum to mechanically agitated composting systems (e.g. a windrow turner) tends to work better compared to static systems (e.g., a forced air static pile). The additional mixing and breakup of the recycled wallboard that occurs in agitated systems helps enhance gypsum's beneficial chemical properties.⁵⁹

4.9.3 Processing

“Several processing methods have been utilized for preparing gypsum drywall for recycling. The two major objectives of processing are separation of gypsum from the paper and the size reduction of the gypsum itself.”⁶⁰

Standard waste processing equipment may be used. Both tub grinders and horizontal grinders have been used successfully. After size reduction, a screen may be required depending on the end-market. Trommel screens have been used in early designs for both size reduction and separation of gypsum from paper.

Drywall dust must be managed throughout each step in the process. Typical process steps may include feedstock stockpiling, grinding, screening, final product stockpiling, and load out into trucks for shipment to market. Ideally, an indoor system would be planned, designed and constructed to help manage the dust and keep the product out of the weather. Such an indoor design could also include mechanical dust collection. This dust collection system could be a series of negative air collection vents including, “vacuum-like” suction devices at critical process components such as the grinder chamber and feed hopper. At the end of this dust control system, filter bags could collect the dust for disposal or recycling. Also, water in the form of a mist will be needed to minimize dust emissions at several key process components. An air quality permit from the MPCA may be required for such a new drywall recycling plant.

⁵⁸ “*Drywall Recycling Market: An Amendment to Compost*” page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

⁵⁹ Ibid. www.GypsumRecycling.org

⁶⁰ “*Processing Gypsum Drywall for Recycling*” page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

Several vendors market self-contained drywall processing equipment. These spreads usually include a grinder followed by a screening system. Built in dust collection systems are typically included as part of the standard equipment package.

A recent development is the use of small grinders directly at the construction site. In this approach, scrap drywall from new construction is separated and processed using a mobile grinder. The recycled drywall is then land applied prior to placement of sod as a soil amendment or a plant nutrient. This approach may be feasible when the soils and grass species show a benefit from the application of gypsum. Several vendors specifically market services or grinders for this type of application.⁶¹ Metro area soils are unlikely to benefit from the application of the material, however this determination needs to be made on a case-by-case basis.⁶²

4.9.4 Potential Issues

In addition to dust, drywall recycling plans should also address the potential for lead-based paint and asbestos.

4.9.5 Summary

This is a promising new recyclable commodity. This *Minnesota CD&I Study* estimates that about 12% of the C&D waste stream going to landfill is comprised of drywall. The processing technology uses a fairly standard approach, although special consideration must be given to design and implementation of adequate dust control systems.

The primary challenge for this material is develop adequate markets. Such market development is challenged by the relatively low landfill tipping fees and that there are no portland cement manufacturing kilns in the Minnesota. A gypsum drywall recycling program may require a concentrated effort, perhaps including additional demonstrations and pilot projects.

⁶¹ “*Recycling Gypsum Drywall at the Construction Site*” page within the www.GypsumRecycling.org web page, a service of the Construction Materials Recycling Association (CMRA).

⁶² “*Characterization of Non-Municipal Solid Waste Stream*” (2004) by URS for the SWMCB.

5 Description of Processing Technologies

5.1 Mixed C&D Waste Processing Technologies

Technologies for separating loads of mixed C&D waste can take many different forms but are commonly a type of mixed waste processing facility. The primary function of a mixed waste processing (MWP) facility is to separate and remove recyclable materials from incoming mixed waste (i.e., divert the recyclable materials from the waste stream). The MWP facility can be a “stand alone” facility or it can be part of a “front-end separation” process at a WTE facility, composting facility, transfer station, C&D waste processing facility such as the focus of this study, balefill, sanitary landfill, or even as part of a recycling facility handling source-separated recyclables. In each case, the MWP facility is tailored to the specific waste streams and end markets for those materials recovered. Therefore, there are several different approaches to facility design, materials targeted for recovery, and costs.

5.1.1 Process

MWP facilities may be developed with either relatively low-technology approaches using primarily manual sorting or more high-technology approaches using some mechanical, automated processes combined with relatively less manual labor.

5.1.1.1 Low-Technology MWP Facilities

The simplest type of MWP facility may be referred to as a “dump and pick” operation. Waste materials are delivered on the tipping floor and recyclable materials are manually pulled from the waste. There may be some equipment such as a grapple, which can separate and lift heavy objects such as white goods, wood, scrap metal, etc. A front-end loader may be used to help move materials around the tipping floor to help separate larger items. This simple approach is sometimes used at a transfer station.

The next step up in relatively low-technology approaches incorporates a conveyor system with manual sorting stations. The mixed waste stream is conveyed up an incline conveyor to an elevated sorting platform, which may be enclosed in a separate room. Sorters pick the targeted recyclables out of the waste stream, deposit the recyclables through chutes into dedicated bunkers, bins, or roll-off containers for each material. The remaining waste materials discharge off the sorting conveyor to be handled via whatever the next technology may be (landfill, balefill, WTE facility, etc.). The sorted recyclables are typically densified (baled, shredded, crushed, etc.) for transport to the end markets.

5.1.1.2 High-Technology MWP Facilities

High-technology MWP facilities are generally more elaborate and costly to operate than low-technology operations, but still incorporate some manual sorting labor. Sorting of the different recyclables has not evolved to the point that sorting is fully automated. Also, as with the low-technology facilities, the extent of automation can vary widely depending on the specific waste stream handled and the targeted end markets.

A high-technology MWP facility for C&D wastes may likely include finger screens, trommel screens, disc screens, elevated sorting line, magnetic separators, and hammer mills. Other potential, but less likely equipment includes air classifiers, eddy current separators, pneumatic conveyors, and balers to separate and densify the recoverable materials.

Different types of screens (finger, trommel, and disc) are used to size-separate the materials, often times into three or more sizes: (1) fines, which may be material too small to be hand sorted; (2) middlings, which may contain recyclables or recoverable materials; and (3) overs, which will contain larger pieces of recyclable material. Typically the materials are conveyed through the process from one piece of equipment to another on belt conveyors.

There is typically some manual sorting of various recyclables such as various types of metal, concrete and brick, corrugated cardboard, and other materials that are marketable. The extent of manual sorting depends on several factors such as the actual type of waste delivered (select C&D loads versus mixed C&D loads); the market specifications (fuel versus OCC), and the follow-up technology and overall goal of the operation.

5.1.1.3 Comparison and Typical Applications

Low-technology and high-technology approaches each have their advantages and disadvantages or more suitable applications.

The low-technology “dump and pick” approach is quite limited in effectiveness and the application may only be suitable for low-volume transfer stations or to target a limited type of bulky recyclable on a tipping floor (such as bulky metal objects). The low-technology approaches that incorporate sorting conveyors have broader applications.

The major advantage of low-technology facilities is that equipment requirements are low, minimizing capital, fuel, and maintenance expense. Equipment downtime is not a significant factor in the rate of waste flow through the facility.

The disadvantages of low-technology facilities include worker safety issues (i.e., bending, repetitive motions, danger from sharp and protruding objects, and general exposure to hazardous materials). The amount of material recovered is highly dependent on the number of laborers, the speed of the conveyors, and the extent of contamination (especially moisture). Hand sorting is most efficient on dry, homogeneous wastes, which is typically the case with C&D wastes.

Most new C&D processing facilities have incorporated mechanical screens (commonly finger screens) and hammer mills into the manual sorting process. The fines from the screens are marketed as “alternative daily cover” (ADC) at sanitary landfills.

The advantages of high-technology facilities may include higher recovery rates of recyclables, as well as higher throughputs of waste per worker, which reduces labor cost per ton.

The disadvantages of high-technology facilities include the increased capital and maintenance costs for equipment and potential equipment related downtime. Contamination may still be a problem.

5.1.2 Typical Markets and Residues

The material products that typically can be recovered by a mixed C&D waste processing facility include metals (ferrous and non-ferrous); aggregate (from concrete, brick, and ceramics); wood as a mulch, bedding, or biomass fuel; alternative daily cover (ADC) for replacement of soil at sanitary landfills, and a biomass fuel or refuse-derived fuel. The mix of products depends on the incoming waste stream and locally available uses.

The markets for the recyclables include the standard markets utilized by source-separated recycling programs. These include paper mills, insulation manufacturers, aluminum mills, metal mills, and plastic recyclers. Wood markets include mulch and wood fuels.

It should be noted that recyclables recovered via MWP facilities have a higher likelihood of contamination. Depending on market specifications and economic conditions, marketing recyclables from MWP facilities may be more difficult than from source-separated programs.

An MWP facility is used to remove the targeted recyclable material from the mixed waste stream delivered. The recovery rate in a MWP facility will vary significantly depending on the composition of the waste stream delivered. A MWP handling only C&D wastes and producing an acceptable ADC product with the markets available currently in Minnesota could recover close to 70% of incoming C&D materials.

5.1.3 Typical Equipment

Technologies for processing mixed C&D waste can include many different types of mechanical processing and sorting system configurations. More and more, the C&D processing facilities include more sophisticated equipment or high technology. These types of operations require more equipment than low-technology (i.e., salvaging or dump & pick) or intermediate-technology operations (accepts primarily one to two types of C&D material), but still incorporate some manual sorting labor. Automated sorting processes have not evolved to the point where a facility can be fully automated; therefore manual picking stations are still required when mixed C&D waste is recycled into marketable end-use commodities. High-technology facilities are typically designed for operations with high throughput volumes (500 plus tons per day) of mixed C&D materials.

The high-technology approach can be applied to more types of waste streams and process a larger daily volume. However, incoming material that is kept clean and dry will also result in higher recovery rates.

A high-technology mixed C&D waste processing facility may include the following equipment and processing techniques:

- ◆ **Conveying Equipment** - Conveyors transfer materials from one location to another. The most common type of conveying equipment used to process C&D is a belt conveyor which consists of a strip of belting material that is looped around a shaft on each end.

- ♦ **Crushing/Reducing Equipment** - Size reduction is the unit operation in which waste materials are mechanically reduced in size. The objective is to obtain a product that is reasonably uniform and considerably reduced in size in comparison with its original form.
- ♦ **Screening/ Separating Equipment** - Screening is a unit operation used to separate mixtures of materials of different sizes into two or more size fractions by means of one or more screening surfaces.
- ♦ **Magnetic & Electric Field Separation** - Uses the electrical and magnetic properties of waste materials to separate them.
- ♦ **Manual Picking Station** - An elevated platform with a conveyor and a catwalk along both sides of the conveyor. Manual sorting is done by removing specified items from the conveyor and dumping them in the appropriate chute provided to be deposited in the bunker below.

A more detailed listing of equipment and processing techniques in mixed C&D waste recycling facilities can be found in Appendix Q.

5.1.4 Processing Facility Operating Experience

There are currently two mixed C&D processing facilities in operation in the Des Moines, Iowa, market area. They have been in operation and reporting their operating tonnages by incoming tons and outgoing tons by material type to the local public solid waste agency (Metro Waste Authority [MWA]) since 2004. Table 5-1 provides a summary of the annual tonnages for each facility for the MWA fiscal years 2004-05, 2005-06, and year-to-date for the current fiscal year. A detailed break down by the month is provided in Appendix R. These facilities are operating in the same market that the C&D waste composition data shown in Table 3-3.

Both of the facilities began operations producing an alternative daily landfill cover (ADC) product. The first year, both facilities recovered over 85% of incoming tonnage. However, as has been found to occur, the ADC that is produced when grinding the mixed C&D waste stream, which still contained sheetrock, eventually caused hydrogen sulfide odors at the MWA sanitary landfill. Thus, the use of ADC has been discontinued by MWA, causing the C&D processing facilities to seek, test, and attempt to develop other markets. The largest potential market is a type of refuse-derived-fuel (RDF) or biomass fuel. Table 5-1, shows how the percentage of ADC produced over time declined with other products such as the RDF and biomass increasing somewhat. There may not be enough markets available to handle all the RDF produced (due to air emission requirements or economics) and the facility operators continue their market development modes.

It is interesting to note the types of materials each facility is separating and the relative percentages of those materials. Cardboard makes up a relatively small percentage for each facility. Common products include aggregate, crushed stone, metals, and wood.

Table 5-1 Metro Waste Authority C&D Tons Reported by Two Area Processors¹

	FY 04/05		FY 05/06		FY 06/07 ²	
	Total	%	Total	%	Total	%
Incoming Tons						
C&D	91,065.33		108,817.25		79,867.04	
Concrete	138.43		101.98		7.35	
Shingles/Asphalt	4,908.00		4,900.00		145.51	
Woodchips/pallets	--		--		2.74	
ADC/dirt	--		--		3,385.54	
	<u>96,111.76</u>	100.00	<u>113,819.23</u>	100.00	<u>83,408.18</u>	100.00
Outgoing Tons:						
ADC	53,603.89	55.77	45,251.54	39.76	19,471.00	23.34
Aggregate/Concrete	4,506.47	4.69	21,012.96	18.46	16,985.07	20.36
Metal	6,749.63	7.02	8,063.58	7.08	4,601.95	5.52
RDF	Not produced		2,784.44	2.45	5,552.48	6.66
Bedding/Wood Waste	9,900.19	10.30	3,084.07	2.71	2,447.66	2.93
Wallboard	396.74	0.41	0.00	0.00	0.00	0.00
Cardboard	3,195.93	3.33	1,538.70	1.35	809.12	0.97
Boiler Fuel	662.14	0.69	73.20	0.06	0.00	0.00
Paper	345.41	0.36	26.49	0.02	6.40	0.01
Crushed Stone	4,094.13	4.26	4,916.43	4.32	0.00	0.00
Tires	12.03	0.01	21.84	0.02	7.65	0.01
Brick	Not listed		209.22	0.18	123.47	0.15
Plastic	136.24	0.14	97.38	0.09	38.80	0.05
Biomass	Not produced		194.38	0.17	260.98	0.31
Residue Bypass/Reject	7,554.24	7.86	12,519.23	11.00	12,376.20	14.84
	<u>91,157.04</u>		<u>99,793.46</u>		<u>62,680.78</u>	
Total Tons Recovered	83,602.80	87.0	87,274.23	76.7	50,304.58	60.3

¹ Source: Ron Lacey, Chief Financial Officer, Metro Waste Authority, Des Moines, Iowa.

² FY 06/07 data provided through March 2007 (three quarters of the year).

Appendix S provides a copy of a PowerPoint presentation made by one of the facility operators at the Fall, 2006 Iowa Solid Waste Conference. The presentation shows some of their process along with efforts to promote the use of the fuel product including various test results conducted on the fuel product.

5.2 Generator Site – Planning, Processing and Recovery Steps and Equipment

Building demolition projects are often a part of a larger “remove and replace” construction project. Owners may contract with a primary contractor that uses a specialized demolition

company as a subcontractor. Demolition plans are often detailed as part of the overall project bid specifications. Each project is unique and each owner will have a different set of demolition specifications within the boundaries of their budget and government regulations.

Demolition projects range in size and type from a small, single family residential house to extremely large commercial/industrial / institutional buildings or public works structures (e.g., bridges). The planning for deconstruction, other materials reuse, recycling and recovery will depend on the unique circumstances of each project. But in general, the larger more industrial buildings will tend to have higher recovery rates. For example, one of the demolition contractors interviewed mentioned a recent bridge demolition project that resulted in 100% recovery. The smaller residential projects tend to result in proportionally more mixed C&D materials not suitable for recovery. Often, the concrete slab on grade and foundation are the only two items that can be cost-effectively recycled during demolition of a house given the extremely competitive marketplace today.

Planning and design steps may include initial budgeting, preliminary site reviews and surveys, bid specification development, contract letting, detailed deconstruction/demolition/recycling design plans including commodity inventories, permitting, and salvageable materials auctioning. Operational steps may include preliminary salvage for reuse, pre-demolition abatement, full dismantlement/demolition, recycling, further excavation (including any contaminated soil removal/remediation/treatment), utilities installation, preparation of the final subgrade/base for new construction, other final earthwork and site clean-up.

If required during pre-demolition abatement, a project may need to remove:

- ◆ Asbestos containing material (ACM);
- ◆ Lead-painted materials;
- ◆ Other types of treated wood;
- ◆ Mercury containing items;
- ◆ Any device with poly-chlorinated biphenyls (PCBs);
- ◆ Any appliance with Freon, oils, hydraulic fluids;
- ◆ Other RCRA-specified hazardous waste; and/or
- ◆ Tank removal.

Demolition contractors will utilize a wide variety of equipment and processes to deconstruct and/or take down structures. Demolition cranes mounted with wrecking balls and rakes are most often employed to bring high-rise buildings to the ground. While it is rarer, boom mounted scrap/demolition shears and magnets may be used to help separate materials while bringing the structure down. Sometimes a building must be deconstructed and dismantled more slowly (e.g., floor-by-floor, piece by piece) due to site constraints (e.g., fully occupied and operating businesses in adjacent buildings; street traffic; etc.). Other owner-imposed constraints will often dictate deconstruction methodology. In these situations, source separation and hand-held tools may help increase recovery rates. Alternative demolition plans may include high-tech explosive charges whereby the entire structure is dropped to the ground in a matter of seconds in very dramatic fashion.

Once the structure has been dropped “on the ground”, another set of equipment may be utilized to further process the material for on-site use and/or shipment for recovery or disposal. Metal and concrete cutting/reduction devices include boom mounted:

- ◆ Scrap/demolition shears,
- ◆ Crackers/crushers, and
- ◆ Pulverizing hammers.

Hand held and boom mounted cutting torches are often used to reduce metal to specified size lengths suitable for recycling.

Once the building rubble is size reduced, common materials moving equipment used include:

- ◆ Grapples,
- ◆ Crane-mounted magnets,
- ◆ Wheel loaders,
- ◆ Bulldozers,
- ◆ Crawler track loaders,
- ◆ Skid steers, and
- ◆ Excavators.

Concrete may be loaded in the form of large chunks into large dump body trucks or stockpiled for crushing on site. Contaminated soil that must be removed is normally loaded out directly. Occasionally, contaminated soil is treated “in-place” on the site without removal.

On-site, mobile, concrete crushing systems or “spreads” often will include two crushing stages. The primary crusher may be a jaw crusher to reduce the chunks down to 3-inch minus. The secondary crusher may be cone crusher to further reduce the aggregate down to its final product size of 1-inch minus. Screening equipment most often includes vibratory deck screens, but rotary trommel screens may also be used to size the recycled aggregate products.

A series of conveyor-mounted magnets are always in use and a critical processing component within the crushing spread. For example, the two crushers’ exit conveyors may each be mounted with one overhead belt magnet and a pulley head magnet to provide for ferrous removal. These four magnets, coupled with manual separation before and after crushing, can achieve nearly total recovery of the ferrous metal. However, sometimes the rebar and other reinforcing steel is too contaminated with structural concrete. Further on-site processing of this low-value scrap metal is not cost effective. Therefore, some of the highly contaminated ferrous is not recovered on-site, but may still be recoverable through centralized processing at an off-site facility.

Dust control is an essential element of overall project planning, detailed design, demolition and recovery operations. Watering of the site, building demolition working face, and temporary gravel pads and access roads is a standard practice that is most often required as part of local and state permits. The design objectives are to:

- ◆ Reduce dust generation,
- ◆ Prevent on-site health and nuisance concerns for workers, and
- ◆ Maintain operational aesthetics as much as possible as part of local public relations.

Watering is accomplished either through specialized dust control “mistors” or simple fire hoses. Often, the demolition cranes have hose mounted nozzles attached as a standard part of the equipment features and operation.

Access roads and public streets adjacent to the demolition project site are often swept and watered to clean up the road dust that inevitably is tracked off-site by heavy construction trucks leaving the site. Rip rap type of large recycled rock is often installed as an apron at the exit gate to help “knock off” the mud and dirt from exiting truck tires.

6 Application of Composition to Quantity Data

6.1 How Important is Source Separation?

6.1.1 Introduction

The RFP for this project requested a discussion of quality issues associated with the waste materials depending on the level of aggregation as this relates to marketing for recovery (i.e., How important is source separation?). Other questions inherent in this could be – Is source separation better than mixed waste processing? Can materials be marketed if they are mixed with other materials? The answer generally is—It depends.

6.1.2 Materials Marketed Primarily Via Source Separation

Earlier sections of this report documented the extensive and mature aggregate recycling industry and infrastructure. Concrete from both road pavement and demolished building facilities is routinely “source separated” and processed for recycling. Concrete is normally used back into the same job site as aggregate base or trucked as a valuable commodity to an intermediate recycler. Similarly, asphalt pavement from old roads or parking lots associated with demolition projects is routinely recycled. Reclaimed asphalt pavement (RAP) is recycled back into aggregate for use either as unbound base or as for use as a recycled supplement back into hot mix asphalt (HMA). Therefore, if recyclable, these concrete and asphalt materials generally do not find their way into the “mixed” C&D stream and are not landfilled or otherwise disposed.

Other building materials that can be economically reused for their original purpose (such as windows, doors, hardware, cabinets, lighting fixtures, plumbing fixtures, precious wood beams, etc.) should be recovered as part of deconstruction and kept out of the remaining mixed C&D wastes. Section 3.4 discussed some of the ongoing deconstruction and reuse programs and companies that are emerging as alternatives to demolition and mixed C&D recycling.

Carpeting is starting to be recovered more often in the Twin Cities metro area. Used carpet and padding appears likely to be better source separated from the remaining waste streams and is likely more easy to accomplish. Often times carpet replacement is the only or primary renovation occurring and is handled by carpet installers rather than general construction contractors. It should be fairly convenient to source separate and deliver carpet and padding to the proper processing location.

6.1.3 Materials Recovered for Markets Based on Cost/Benefit Decisions by Private Contractors

The private sector takes pride in making business decisions based upon their perception of the “bottom line.” If the economics of recovery are better than the economics of disposal, private contractors typically find a way to recover materials rather than pay someone for disposal. Relative material quantities, quality of materials (including issues of contamination and environmental regulatory requirements), convenience at the job site, and market prices for materials are critical factors in this decision.

C&D material categories from this study that routinely fall in this group include recyclable:

- ◆ Metals (both ferrous and non-ferrous)
- ◆ Dimensional wood
- ◆ Concrete, asphalt, and brick

If the materials above are present in adequate quantities, are clean enough, there is space at the job site, and transportation costs and market prices are adequate, these materials can be cost-effectively source separated and recovered.

Roofing and/or shingles is another category that could easily be placed in this group once an adequate, consistent market is developed. Sheetrock/gypsum wallboard may also be a candidate for market development, but less work has been completed on this commodity.

6.1.4 Materials Cost Effectively Recovered Via Mixed C&D Processing

There is a key difference in the level of contamination of recoverable materials from mixed C&D wastes than from mixed municipal solid waste (MSW). Mixed MSW contains significant amounts of wet wastes such as food and liquids that are not present in C&D wastes. Those food wastes and liquids come in contact with recyclable materials left in the mixed MSW and contaminate the recyclable material. The materials in mixed C&D loads are typically much drier than mixed MSW and therefore tend to not be contaminated beyond market specifications. Mixed C&D processing facilities are able to routinely recover materials such as ferrous and non-ferrous metals for metal markets; concrete and brick as aggregate; wood for a variety of markets such as mulch; and even paper such as corrugated cardboard that was not contaminated during the construction or demolition process itself.

Thus, the marketability of metals, aggregates, wood, and corrugated cardboard from C&D is not dependent on source separation.

6.1.5 Additional Markets Via Mixed C&D Processing

In addition to the potential recovery of aggregate, metals, and wood, there are some added materials that can be produced and marketed via mixed C&D processing. Materials to produce biomass fuel can also be recovered at a mixed C&D processing facility. Depending on the market specifications of the fuel market (extent of air pollution control equipment, pricing, etc.), this can not only include the wood categories, but also other combustible materials that remain in the C&D wastes delivered to the facility.

Screening the dirt and fines out of mixed C&D provides a material that can be effectively marketed as an ADC depending on the presence of significant quantities of wallboard causing problems. Screening out the dirt and fines is a relatively simple process.

6.1.6 Summary

There is a role for both source separation and mixed C&D processing to increase recovery of targeted materials from this waste stream. There is increasing experience that promotion of deconstruction and other reuse activities is cost effective and beneficial. But it also appears to

require a catalyst or motivation provided by the public sector including an investment in public education and promotion.

A key audience for such public education will be the owners of buildings and other facilities. All owners should be receptive to the reuse or recovery practice if it saves them money. Many will be willing to learn about voluntary compliance options with existing environmental regulations. And a smaller share may be willing to consider alternatives if it can be demonstrated to make a significant difference in protecting the environment, as long as it doesn't cost too much more than the traditional method.

Mixed waste processing provides convenience for the generator and contractor in that no "behavior change" is required by them in order to recover more material. Mixed C&D processing can cost-effectively recover materials meeting metals, aggregates, and fiber markets while also recovering large quantities of materials with more tolerant market specs (ADC and fuel).

The State of Minnesota will be best served with a continually evolving balance of reuse, source separation and mixed C&D recovery.

6.2 Estimated Availability of Targeted Materials

Estimating the amount of materials that can be reused, recycled, or other wise recovered from the C&D waste stream is very preliminary. This is an early planning exercise that may be useful as a policy discussion tool. There are many, many variables that will yet affect actual results. Specific program, project, facility design or business development should be based on more rigorous C&D waste characterization study of more targeted materials and generators. Nevertheless, there is some value in applying the data developed in this study to get some order of magnitude of the potential for increased recycling and recovery.

Table 6-1 titled "Metro Area Preliminary "Aggressive" Material Reuse/Recycling and Recovery Projections" applies the waste composition task results to the projected metro area C&D quantities developed from the 2006 quantity data from Table 3-1 for 11 facilities generally located in the metro area. The total metro area tonnage is projected at 1,029,347 tons. The percent composition of each of the materials from the waste sort results are applied to the total tonnage to provide an estimate of the total quantity of each of the materials.

The column labeled "Reuse/Recycling" provides an estimated aggressive recycling recovery rate for the various potentially recyclable materials. For example, some of the corrugated cardboard generated at C&D sites is contaminated and no longer recyclable. A relatively high projection of recyclability is 50%. When this percentage is applied to the available tons, the result is a potential total recycled corrugated cardboard tonnage of 13,473 tons. Some of this could be recovered as source separation and some at a mixed C&D processing facility. Such is the case for most of the rest of the Reuse/Recycling rates and tonnages, with the exception of the rate and tonnage for textiles/carpets. This is primarily used carpet and foam padding. The carpeting arriving at a mixed C&D processing facility will likely be too contaminated to recycle. Thus, this material would need to be reused/recycled via a source separation process. The 50% recycling estimate for textiles/carpets is subject to further discussion.

Table 6-1 shows that of the 1,029,347 projected metro area tons, 219,322 tons could be recycled which is 21.3% of the total metro area projected quantity.

The column labeled “Recovery” provides an estimated aggressive recycling and material recovery rate for each material. The next column provides a comment for which type of product is marketed. Some of the materials are assumed to be reused/recycled (including mulch), some made into biomass fuel, and some made into ADC. These quantities are carried over to the next four columns (including the amount left for landfilling).

This simple preliminary analysis results in an estimated tonnage for the metro area as follows:

Type of Use	Tons	Percentage
Recycling	219,322	21.3%
Biomass Fuel	309,638	30.1%
ADC	173,369	16.8%
Landfill	327,029	31.8%

As noted in the introductory paragraph to this subsection, these “numbers” at this point in the overall planning process should be considered on a very broad basis. There will be many variables affecting future results.

Table 6-1
 Metro Area Preliminary "Aggressive" Material Reuse/Recycling & Recovery Projections

Type	Percent	Statewide Quantity Available	Metro Area Quantity Available	Metro Area Only Projections										
				Preliminary "Aggressive" Estimates				Type of Use	Projected Quantities					
				ReUse/Recycling		Recovery			Recycling	Fuel	ADC	Landfill		
%	Tons	%	Tons											
Paper														
Corrugated/brown paper	2.6%	39,509	26,947	50%	13,473	100%	26,947	Reuse/Recycle & Biomass Fuel	13,473	13,473				
Other paper	1.6%	24,572	16,759	0%	0	100%	16,759	Biomass Fuel		16,759				
<i>Subtotal PAPER</i>	4.2%	64,080	43,706		13,473		43,706							
Plastic														
Marketable Plastics	0.6%	8,614	5,875	50%	2,938	100%	5,875	Reuse/Recycle & Biomass Fuel	2,938	2,938				
Other plastics	3.8%	56,902	38,809	0%	0	100%	38,809	Biomass Fuel		38,809				
<i>Subtotal PLASTICS</i>	4.3%	65,516	44,685		2,938		44,685							
Metal														
Ferrous scrap	2.8%	42,708	29,129	100%	29,129	100%	29,129	Reuse/Recycle	29,129					
Non-ferrous	0.5%	8,065	5,500	90%	4,950	90%	4,950	Reuse/Recycle	4,950				550	
<i>Subtotal METAL</i>	3.4%	50,773	34,629		34,079		34,079							
Glass														
Glass	0.8%	12,764	8,706	0%	0	0%	0						8,706	
<i>Subtotal GLASS</i>	0.8%	12,764	8,706		0		0							
Yard Waste														
Yard waste	0.2%	3,460	2,360	0%	0	100%	2,360	Biomass Fuel		2,360				
<i>Subtotal YARD WASTE</i>	0.2%	3,460	2,360		0		2,360							
Textiles/Carpets														
Textiles/Carpets	3.7%	56,552	38,571	50%	19,286	100%	38,571	Reuse/Recycle & Biomass Fuel	19,286	19,286				
<i>Subtotal Textiles/Carpets</i>	3.7%	56,552	38,571		19,286		38,571							
Electric Wastes														
Electric Wastes	0.1%	2,066	1,409	0%	0	0%	0						1,409	
<i>Subtotal E-WASTES</i>	0.1%	2,066	1,409		0		0							
WOOD														
Tree Wastes	0.2%	3,209	2,189	0%	0	100%	2,189	Biomass Fuel		2,189				
Non-treated Wood	3.2%	48,995	33,417	50%	16,708	100%	33,417	Mulch & Biomass Fuel	16,708	16,708				
Green-Treated Wood	0.8%	11,470	7,823	0%	0	0%	0						7,823	
Other Woods	18.3%	275,676	188,023	0%	0	100%	188,023	Biomass Fuel		188,023				
<i>Subtotal WOOD</i>	22.5%	339,350	231,451		16,708		223,628							
Concrete														
Concrete	9.7%	146,130	99,667	90%	89,700	90%	89,700	Reuse/Recycle	89,700					9,967
<i>Subtotal CONCRETE</i>	9.7%	146,130	99,667		89,700		89,700							
Brick														
Brick	5.6%	84,329	57,516	75%	43,137	75%	43,137	Reuse/Recycle	43,137					14,379
<i>Subtotal BRICK</i>	5.6%	84,329	57,516		43,137		43,137							
Sheetrock														
Sheetrock and wallboard	11.6%	175,066	119,403	0%	0	0%	0							119,403
<i>Subtotal SHEETROCK</i>	11.6%	175,066	119,403		0		0							
Roofing														
Roofing (incl. shingles & tear off)	15.2%	229,838	156,759	0%	0	10%	15,676	Incidental ADC & Biomass Fuel		7,838	7,838		141,083	
Flat roofing	1.9%	28,989	19,772	0%	0	0%	0						19,772	
<i>Subtotal ROOFING</i>	17.1%	258,827	176,531		0		15,676							
Dirt/Fines														
Dirt/fines	16.1%	242,699	165,531	0%	0	100%	165,531	ADC					165,531	
<i>Subtotal DIRT/FINES</i>	16.1%	242,699	165,531		0		165,531							
Unused Product/Haz Wastes														
Hazardous Wastes	0.3%	3,948	2,692	0%	0	0%	0							2,692
<i>Subtotal HW</i>	0.3%	3,948	2,692		0		0							
Incidental/Other														
Miscellaneous	0.2%	3,651	2,490	0%	0	50%	1,245	Biomass Fuel?		1,245				1,245
<i>Subtotal INCIDENTAL/OTHER</i>	0.2%	3,651	2,490		0		1,245							
Totals	100.0%	1,509,212	1,029,347		219,322		702,318		219,322	309,628	173,369		327,029	
				Percent	21.3%		68.2%		21.3%	30.1%	16.8%		31.8%	

Statewide Tonnage 2006 1,509,212
 Metro Tonnage 2006* 1,029,347
 (*Includes Burnsville SLF, Dawnway, both Dem-Con LFs, Demolition Landfill Services, Elk River SLF, Rich Valley, SKB Rosemount, Spruce Ridge, Veit Northwood, & Vonco II)

7 Description of Barriers and Opportunities to Increased Reduction and Recovery

7.1 Barriers

7.1.1 Economics

The primary barrier that limits the amount of recovery of CD&I materials cited by many sources interviewed as part of this study is economics. The net costs of source separation, collection, sorting, processing, and marketing potentially recoverable materials in many instances is higher than the comparable cost of simply collecting the materials at a job site and hauling to a landfill for disposal. Inherent in the cost differential are labor rates for construction workers at job sites (contractors want workers doing productive activities, not sorting minor quantities of scrap), labor rates for sorting, capital costs for processing equipment, relatively low cost tipping fees at competing landfills, and relatively low values received for marketing most of the recovered materials.

7.1.2 Lack of Markets

The lack of viable markets for C&D materials potentially recovered obviously limits recovery. The primary examples of materials very predominantly present in C&D wastes that could be targeted and recovered are roofing and sheetrock. Together, these materials can make up from 20% to 35% of the C&D waste stream as currently disposed in landfills. For example, Table 3-10, the waste composition study conducted for this report, indicates that approximately 15% of C&D could be recovered if there was an acceptable market for recovered tear-off asphalt shingles. A market for sheetrock could increase the recovered percentage by another 10%. These materials are relatively easy to identify, are generated at a site over a relatively short period of time, and could fairly easily be targeted at the job site or at a mixed C&D processing facility. Nevertheless, without a viable market for these materials, the majority will continue to be disposed.

Mn/DOT specifications are critical to use of C&D materials. The largest volume of any material recycled today is in the form of recycled aggregates derived from crushed concrete and reclaimed asphalt for use in road base construction. However, Mn/DOT specifications need continuous improvement as more aggregate recycling field experience and technology grows and matures. Mn/DOT's current specifications relating to recycled shingles in hot mix asphalt (HMA) do not allow tear-off shingle scrap, only manufacturers' scrap. Also, the current Mn/DOT specifications that do not allow any visible amounts of recycled brick in aggregate used for road base are being implemented inconsistently.

Lack of markets is also a concern for biomass fuels. Much of the wood that could be recovered from the C&D wastes is classified as "Other Woods (18.3%)." This may include composites, furniture, plywood, etc. that will make a fuel with high Btu content, but require adequate air pollution control equipment at the combustion facility. Additional combustion plant capacity is likely required to fully tap this resource.

Use of C&D waste as alternative daily cover (ADC) is another “market” for residues from mixed C&D processing. This potential market was undergoing further review by the MPCA at the time of this report. Such market development for ADC recovered from mixed C&D, while not defined as “recycling” per se, will help with the overall economics of C&D recovery. Recovery of ADC should be just one piece of the larger, comprehensive approach to market development for C&D waste.

7.1.3 Low Volumes

There are many relatively small C&D recycling, transfer, and landfill facilities located around Greater Minnesota. The total volume of potentially recyclable material accumulated at any one site may be relatively small. Therefore, the quantities of any one potentially recoverable material may be inadequate to justify processing and shipment to market. This is part of the economics limiting material recovery, but bears special emphasis in light of the concerns raised by the Minnesota Solid Waste Administrators regarding concerns for illegal dumping, unfunded mandates, and lack of local markets.

7.1.4 Lack of Attention by the State and Counties

The focus of the Minnesota Waste Management Act and most public policy has been on MSW for many years. C&D and Industrial Wastes have not been a priority. One reason for the relative lack of attention to the recycling of CD&I materials is that these items are defined by State law as separate waste streams and thereby differentiated from MSW. Subsequent state agency rules, state programs, and local government policies are all derived from this definition and management scheme within the Minnesota Waste Management Act.

This lack of attention to CD&I materials may not necessarily be a barrier, but it appears that the lack of governmental attention on recovering potential resources from these wastes has contributed to lower recovery rates. Nevertheless, there is a growing interest in increased recovery of materials from C&D wastes on a national basis and from industry entrepreneurs. It is not just a phenomenon here in Minnesota.

7.1.5 Priorities

C&D and Industrial waste is not as “personal” as residential MSW, for example. Historically, individual decisions about materials management transactions are based on the lowest cost, short-term economics. C&D recycling has not drawn the attention of “customer demand” by the average home owner that is placed on curbside collection of recyclables. Industries pay more attention to industrial waste material recovery as part of cost control. That transaction is more closely linked to typical reuse or recycling processes than C&D material recovery. C&D wastes are not typically as potentially troublesome from an environmental protection standpoint. Relative to MSW, C&D waste is more inert, less likely to have an odor, attract vermin, and just less offensive. All these characteristics have tended to contribute to a lack of inertia to start focusing on the opportunities. CD&I waste has not been a priority. This too may not be a barrier, but contributes to the lack of recovery to date and may be a factor in the length of time it takes to increase recovery.

7.1.6 Awareness

There is a significant amount of CD&I materials reuse, recycling, and recovery that has not been fully documented. Many of these alternative management strategies are relatively new compared to the historically normal practice of land disposal. This lack of empirical data and awareness about ongoing reuse, recycling, and recovery activities is a barrier to enhanced development of these alternatives. This report presented data from case studies of on-site C&D reuse, deconstruction and recycling from other communities around the country.

It is likely that many demolition contractors have not had the opportunity to learn about such cost saving alternatives. Also, the perception may exist that there are “no markets” for reusable and recyclable C&D materials. Finally, there is a need to conduct local project demonstrations in Minnesota that more visibly prove that the net costs (after material sales and avoided disposal costs) can be equal to or lower than the more traditional practice of the exclusive use of land disposal as the preferred waste management option.

7.1.7 Enforcement of Existing Regulations is Not Consistent or Uniform

Several of the demolition and aggregate recycling companies interviewed indicated that local and state agencies do not enforce environmental regulations consistently. There are very intense, economic pressures to keep operating costs to an absolute minimum; otherwise a company will not be competitive to stay in the business long-term. It is frustrating to many legitimate companies because they will include the full cost of compliance in their bid estimates. Yet they must compete with “fly-by-night” operators who claim they will follow all regulations in their bid response and then get away with taking illegal short-cuts. For example, most reputable companies will include the costs of full compliance with asbestos abatement regulations, including a ten-day notice period. However, other companies may claim to be in full compliance while intentionally mixing asbestos containing material into their mixed C&D loads or otherwise avoiding the proper certification procedures.

This problem of lack of uniform enforcement of current environmental regulations needs further review to document the extent of this challenge. This issue may be an opportunity to both “level the playing field” by improving compliance with environmental regulations, while at the same time promoting additional recovery. The challenge should include as a target audience both project owners as well as the varied interests within the demolition, waste and recycling industry.

7.2 Opportunities

There are significant opportunities for increased reuse and material recovery, primarily from C&D wastes. By its nature, C&D waste does not contain as many different types of materials as MSW. It is easier to identify and target potentially recoverable materials. It may be inherently easier to approach recovery from C&D wastes than from mixed MSW.

7.2.1 Deconstruction

Despite the common perception of many in the demolition industry, there seems to be growing evidence that deconstruction activities for at least some buildings hold promise for the future. Earlier sections of this report documented successful C&D reuse experiences with programs

such as ReStore (Habitat for Humanity), the ReUse Center Store and DeConstruction Services at the Green Institute, and the case study projects from the Dubuque, Iowa area. These case studies provide support for the potential expansion of reuse and deconstruction as a preferred approach.

The clear trend towards more restrictive environmental regulations will continue. Regardless of the exact enforcement mechanism, these regulations can be coupled within a larger outreach plan to include public education and technology transfer. For example, as facility owners (e.g., owners of old buildings or roads needing reconstruction) gain more understanding of their legal responsibilities and obligations as C&D waste generators, they may be more receptive to environmentally preferable practices for reuse, recycling and recovery.

7.2.2 Regulation

There is a need to further document the issue of inequitable or inconsistent enforcement of existing environmental and other regulations. Private sector investments will be more likely if there is more certainty not just about the promulgation of rules but consistent, fair and reasonable enforcement.

7.2.3 LEED™ and Other Sustainable Building Initiatives

The promotion of sustainable building initiatives such as LEED™ (Leadership in Energy and Environmental Design) by architects and engineers has been cited as a significant impetus to waste and toxicity reduction as well as C&D material recovery. There are companies in the Twin Cities using this approach to increase recovery of targeted materials. This could represent a significant opportunity to increase recovery. Further discussion about the implementation, monitoring, and enforcement details of LEED™ is still needed.

Other similar sustainable building programs that should also be monitored and invited to help with implementation and outreach include:

- ♦ The National Association of Home Builders (NAHB) “Model Green Home Building Guidelines;”
- ♦ The Center for Sustainable Building Research (CSBR) at the University of Minnesota, including their Minnesota Sustainable Building Guidelines (MSBG); and
- ♦ The Green Remodeling and Green Homes Program standards being developed collaboratively by the Builders Association of the Twin Cities (BATC), the National Association of the Remodeling Industry of Minnesota (NARI MN), and the Green Institute.

The opportunity for “leveling the playing field” through standardized measurement definitions, best practices for documentation, and independent certification of recycling rates should be explored.

7.2.4 Markets

Table 7-1 provides a summary of the markets for various materials in the C&D waste stream. There are some materials with established markets that are also present in significant quantities in C&D wastes. These include wood, concrete, asphalt, and ferrous metals. These can be targeted and recovered via both source separation and mixed waste processing. Both public and private market development efforts on these large commodities have resulted in huge quantities of material being diverted from landfills. These market development efforts should continue. For example, MPCA and the counties should continue their collaboration with Mn/DOT to refine the State materials specifications and quality control/quality assurance practices for recycled aggregate products.

Table 7-1 Material Market Summary

Material	Composition Percentage	Market Status
Metals	3.4	Established
Concrete	9.7	Established
Brick	5.6	Mn/DOT specs need amending
Non-treated wood	3.2	Established
Roofing (shingles)	15.2	Significant promising efforts
Drywall	11.6	Not promising
Carpeting	3.7	Promising local/national efforts
Biomass fuel	30.1	New combustion plants being evaluated
C&D fines as ADC	16.8	Approved by MPCA, but under reconsideration

As noted, shingles and sheetrock both make up a significant quantity of the materials, especially in construction wastes. Markets are needed for these materials. Tear-off shingles markets may be closer to reality with the potential to use shingles in asphalt applications. Sheetrock market potential is less well developed at this time.

There has been a recent development to recover used carpeting and foam padding. These materials are relatively easy to separate at the source when carpet is replaced. Delivery by carpet installation contractors to the intermediate processor can be accomplished rather than to or by the waste industry.

There is growing interest in the wood products present in C&D to be recovered for use in biomass fuel. This is the case not only around the United States, but also here in Minnesota. One of the more promising potential markets for biomass fuel could be the development efforts to provide the Rock-Tenn paper mill with a new steam plant.

ADC represents a potentially significant opportunity for C&D material recovery. From a pure recycling standpoint, it may seem that recovering the fines to use as ADC in a landfill is not really landfill abatement because the material goes in a landfill. There are two other factors to consider in this case. One, the ADC takes the place of soil as daily cover. Thus, there is a

beneficial use involved as the ADC is taking the place of the soil cover, thereby reducing the use of valuable, virgin soil and extending the landfill life. Secondly, and perhaps more important from a standpoint of increasing C&D material recovery, is the impact being able to produce and market ADC has on the C&D waste processor. The ADC can be marketed at a much lower cost than having to dispose of the material and pay the full landfill tipping fee. Thus, the ADC becomes a very important piece in the overall economics of the C&D recovery facility—cost avoidance for landfill disposal. Nevertheless, there is still significant concern regarding the presence of wallboard in the ADC leading to hydrogen sulfide odors. The use of C&D fines as ADC will continue to evolve via regulatory efforts and Best Management Practices for ADC production and use. As noted, the MPCA is evaluating continued use of C&D as ADC. This issue and market potential is not totally resolved.

7.2.5 Limited Opportunity

There does not appear to be significant opportunity for increased recovery from recyclable paper or plastics. The composition percentages are relatively low. This is not to say that these materials cannot be recovered, it simply indicates that focus on them will not result in large quantities of recovered materials. Also, until dependable markets emerge, there is minimal opportunity to recover significant quantities of sheetrock

7.2.6 Industrial Waste

In general, the opportunities for recovery of additional industrial wastes appear limited. The majority of the industrial wastes currently disposed in landfills are contaminated soils, ash, asbestos, sludges, and foundry sands. Contaminated soils represent the largest quantity. If more materials could be managed on site or via land farming, some significant reduction could occur. The recovery of foundry sands was reported to be increasing from interviews conducted in this study. There are indications that use of these products as ADC is increasing. There could be some additional recovery of selected industrial wastes if a stable biomass fuel market develops that has the appropriate air pollution control equipment.

8 Management Options

8.1 Description of Likely Approaches

There are several different potential management options that have been mentioned in this report or that have similar approaches already in place in Minnesota. Several state and local governments outside Minnesota have implemented programs, created legislation, or provided incentives to businesses in an effort to divert C&D waste from disposal in landfills to secondary markets. Many of these efforts to increase C&D diversion have focused on one of the “Three E’s—Environment, Economics, and Enforcement.” People are motivated to recycle by their environmental ethic (i.e., “recycling is the right thing to do”); by cost savings or cost avoidance (i.e., recycling saves money or is cheaper than other options for disposal); and by requirements to recycle (e.g., mandatory recycling ordinances or material bans).

Table 8-1 presents a summary of various options mentioned throughout this report. They are grouped according to the basic nature being:

- ♦ Education or Environmental Ethnic
- ♦ Economics
- ♦ Enforcement/Regulatory

Table 8-1 includes the concept of the management option, the barrier addressed, and a brief description.

8.1.1 Education or Environmental Ethnic

The first three concepts are related to promoting sustainable building guidelines such as LEED™ (Leadership in Energy and Environmental Design) or other resources. The first concept is that the government sector should help accelerate the current trend towards sustainable building practices. For example, building owners, architects, and contractors can use as much peer-reviewed and generated information on this subject as possible.

The second concept is that the State of Minnesota should work in collaboration with other states and the federal government agencies to transfer the knowledge about solid waste and recycling systems management into the process for improving sustainable building guidelines. This effort should result in a comprehensive set of clear, consistent definitions (e.g., ADC as “recovery” and manufacturing products as “recycling”) and measurement standards (e.g., “residual rates” from mixed C&D recovery facilities). This is a common need regardless of the strategies and policy outcomes of various organizations developing independent standards and guidelines. For example, if USGBC and NAHB can use a common set of recycling definitions and measurement protocols, their collective utility as complementing guidelines will be further enhanced.

Table 8-1 Potential Management Options

Concept	Barrier	Description
Category: Education/Environmental Ethic		
Promoting existing sustainable building guidelines/LEED™ standards	Lack of attention	Reuse, recycling and other recovery building waste materials to receive points toward certification
Recommend further refinement of sustainable building guidelines/standards to more clearly specify recycling and other recovery definitions and measurement standards	Lack of attention	Work with the USGBC, NAHB, the Green Institute and other organizations in lead roles on new and revised sustainable building guidelines.
Develop and finance means of independent certification of C&D recycling rates	Lack of attention	Similar to (or a part of) current LEED™ certification systems. Move away from current practice of haulers and processors self-certifying levels of recycling towards independent certification.
Government agencies providing technical assistance regarding strategies for reduction and recovery	Lack of attention	Helping developers and owners with information. High performance building guidelines, “Code Plus.” Promote best practices via developing networks & forums for designers, gov’t agencies, utilities, etc. Enhanced directories of C&D waste reduction, recycling and recovery outlets. Promoting “Pre Demolition Rules” including removing hazardous materials. Promoting contract language on greener practices.
Set goals for C&D waste diversion	Lack of attention	Similar to MSW recycling goals
Measurement of amount of waste reduction and recovery from representative demolition projects	Awareness	Develop a study, including project sampling and survey methodology, to further analyze full materials flows from pre-selected building demolition and deconstruction projects to more completely document existing waste reduction and recovery patterns. (i.e., this is the material that currently does NOT go to C&D landfills). Use this study to develop technical assistance outreach tools such as: a complete, updated directory of C&D waste reduction, recycling and recovery outlets; model project case studies; and summary of example municipal and county ordinances.
Category: Economic		
Market development	Lack of Markets	Prioritize specific C&D commodities for focused market development assistance (e.g., work to develop: shingles markets, biomass fuels, wallboard markets, etc.)
	Lack of Markets	Shingles – pursue use of tear off shingles in HMA and other market applications
	Lack of Markets	Biomass fuel markets – Combine solid waste and energy policy initiatives to develop combustion facilities capable of handling C&D based biomass fuel
	Lack of Markets	Monitor developments in wallboard industry for potential markets or alternative uses. Consider the use of product stewardship approaches for wallboard.
	Lack of Markets	Monitor the use of C&D fines as an alternative daily cover (ADC) material .
Development credits	Economic	Waive or restructure building permit fees for projects that meet sustainable building standards
Funding incentives	Economic	Payments for meeting LEED™ – type of sustainable building levels

Concept	Barrier	Description
Tax credits	Economic	Property tax credits to building owners for meeting sustainable building criteria
	Economic	Income tax credits for tenant improvements that meet sustainable criteria
	Economic	Credits for recycling processing equipment for C&D recycling facilities
Building/demolition permit deposits	Economic	Getting deposit back requires meeting specific diversion levels with higher refunds for higher diversion
Grant programs	Economic	Provide grants for C&D recovery facilities and programs
Higher tip fees potentially resulting from a private, merchant facility approach	Economic	For example, current RRT / Newport facility tip fees gradually increase over time and landfill tip fees may increase
C&D landfill tax increase	Economic	Use state or local surcharges to raise cost of landfills with revenues directed toward recovery efforts
Differential tip fee/s	Economic	Set higher tip fees for mixed C&D delivery and lower for source separated materials
Change the solid waste management tax on non-MSW	Economic	Similar to current Minnesota solid waste management tax on MSW
Expand SCORE grants to Counties to include C&D	Economic	Create a SCORE like tax revenue applicable to C&D for use on integrated CD&I programs
Category: Enforcement/Regulatory		
Require public buildings & Agencies to meet specific sustainable building guidelines	Priorities	All state agencies, county, and municipal buildings covered
Mandatory C&D diversion percentage	Priorities	Similar to California diversion goals with focus on C&D wastes. Model ordinances developed for local government. Stimulate development by private processors
Ordinance requiring recycling as part of any C&D project	Priorities	Similar to Chicago model using a fine based system with different levels for different size projects
Landfill bans	Priorities	Ban of land disposal of selected materials similar to Massachusetts which addresses disposal, transfer, and contracting for very specific commodities that have adequate markets
License non-MSW collectors	Lack of enforcement	Similar to MSW hauler licensing, used to gather data and regulate the activity

The third concept is that there is a recognized need to develop independent C&D recycling certification systems similar to the developing LEED™ certification programs for verifying building design, construction, and operations. Such independent recycling certification will enhance the credibility of all recycling systems leading to more recycling competition which will likely lead to higher recovery rates. In the end, the already strong influence of the private marketplace will be leveraged for utilizing such legitimate, certified recycling practices.

The fourth concept under Education/Environmental Ethic is for government agencies to provide technical assistance regarding strategies for reduction and recovery to the various stakeholders involved. There are numerous existing state and local programs that can be used to tailor materials locally. Several locations and programs are identified in Section 2 of this report as well as in several of the appendices.

The fifth (C&D diversion goals) and sixth (measurement of existing recovery) concepts may be inter-related. Goals for C&D waste diversion could be established similar to the goals that have been set for recycling of MSW. These would be promoted on a voluntary basis and used to stimulate additional recycling (particularly via the technical assistance service listed in the previous concept). While documenting existing C&D material recovery would be informative and provide “how-to” information for others, it would also be important to know what recycling or recovery is already occurring prior to setting C&D diversion goals. The purpose of setting goals would be to increase recycling and recovery beyond present levels and not to simply accept diversion that already occurs as meeting the diversion goals.

8.1.2 Economic

Market development is absolutely critical to increasing recovery of C&D materials. A comprehensive C&D market development plan should be immediately developed including clear material priorities, timelines and government resource allocations. Market development is needed for shingles, biomass fuels, and wallboard. Refinements to aggregate specifications also appear to be needed. Also, market issues related to ADC were unresolved at the time of this report. These activities involve primarily state agencies and industry trade associations helping to nurture and promote markets for recovered materials until they are adequately developed.

Development credits and funding incentives are used in some locations (see Appendix B), primarily to address the energy conservation aspects of sustainable building development more so than C&D material recovery.

Tax credits could take the form of property tax credits to owners, income tax credits for renter improvements, and/or credits to processors for equipment purchases. These approaches are not directly within the control of the “waste management industry” (SWMCB and the various stakeholders involved in this project). Other approaches are available that are within the purview of SWMCB and the stakeholders.

Building/demolition permit deposits could be set up so that getting the deposit back requires meeting specific diversion levels. This management option is more typically implemented by municipal governments and may not be uniformly implemented around the state. Permit

deposits are more closely linked to diversion than development credits, incentive payments, and tax credits and therefore likely more effective in increasing diversion. Any monies not refunded could also be used to promote C&D recovery. This approach may be a viable “demonstration project” for an interested municipality in the state.

Grant Programs may be patterned after existing grant programs such as the MPCA Capital Assistance Program (CAP). The state uses bonds to fund CAP which cannot be used by private companies. An alternative should be considered to also promote private processing such as targeted market infrastructure development grants.

It was noted in the literature review in this report that tipping fees of \$50 per ton and higher stimulates recovery of material from C&D wastes. The MSW processing facility in Newport, MN recently changed to a merchant facility approach wherein the private operator is responsible for contracting for waste delivery. Contracts are in place with tipping fees gradually increasing over time to over \$70 per ton for MSW. It is not currently known whether other disposal facility tipping fees including C&D will increase to keep pace. If so, this could stimulate additional processing and recovery of materials from several waste streams.

The state and/or counties could assess a tax on C&D wastes or change the current tax on C&D to be more like MSW. The intention would be to increase disposal costs significantly to stimulate more C&D material recovery. As noted, tipping fees of approximately \$50 per ton were found to stimulate more recycling and recovery. This approach will be opposed by C&D landfill owners with part of the concern that a tax increase on C&D landfills will cause the C&D to be delivered instead to MSW landfills. There is currently a \$0.60 state charge per cubic yard on all C&D wastes collected. On an annual basis, this amounts to an estimated \$3,420,000⁶³. This existing revenue could be used to stimulate additional C&D processing.

Differential tip fees would involve a facility setting lower fees for recoverable source separated materials versus mixed loads of C&D wastes. This approach is used mostly by public disposal facilities to create an incentive for generators and haulers to source separate recyclable materials, making them easier to recover.

SCORE grants could be expanded to include C&D recovery activities. Funding would need to be increased, otherwise other recycling activities would not be funded. This approach is familiar to many county staff and was mentioned frequently during interviews and questionnaires.

8.1.3 Enforcement/Regulatory

Requiring public buildings and agencies to meet sustainable building guidelines would apply requirements to all state agencies, county, and municipal buildings. This concept implies increased monitoring and oversight of the existing Minnesota Sustainable Building Guidelines that are already required for new state buildings. This is often times done as a first step to promote the concepts and justify requiring private building owners to follow suit.

⁶³ Source: 2006 PCA facility annual report data compiled by Don Kyser indicate approximately 5,700,000 cubic yards disposed.

Adopting a mandatory C&D diversion percentage would make recovery of a certain percentage of C&D materials a requirement. Potential ordinance adoption at the local level would stimulate private processors. A state level requirement would stimulate processing on a much larger level.

Another regulatory approach would be an ordinance requiring recycling as part of any C&D project. This could be done at the local level as was the case in the city of Chicago which included a fine based system. It could likely be done with a permit deposit approach as well. A variation on this concept could entail a mandatory C&D processing requirement at the state level for certain size projects (i.e., small projects such as single-family homes and commercial buildings under a certain size could be exempted). This may help address economy of scale concerns by the Solid Waste Administrators Association.

Landfill bans are likely the ultimate regulatory approach. Typically only certain materials that have proven markets are included in the ban. This approach will be opposed by C&D landfill operators citing concerns such as causing C&D to be hauled out of the state to other landfills and inspectors citing incidental quantities of the banned material in their inspection reports. The inspections would then reflect badly on the operators for a problem that is somewhat out of their control (the generator and hauler have more control over materials placed in dumpsters and roll-off containers). Nevertheless, landfill bans can contribute to significant diversion activities but need to be considered only as part of larger, more comprehensive market development plan.

Licensing non-MSW collectors would be a regulatory activity aimed at gathering better data about C&D generation. However, there are currently many contractors (especially for roofing projects) that are not based in Minnesota and do not work all year round within the state. Implementation of this concept may be problematic.

8.2 Conclusions and Recommended Approach

Based on the data developed and input from stakeholders, there are three key areas for the Waste Streams Policy Committee to address to increase recycling and recovery of C&D materials. These include:

- ◆ Market development
- ◆ Development of generator incentives
- ◆ Stimulation of C&D processors

Development of markets, particularly for shingles, biomass fuel, wallboard, and glass will allow significant increases in recovery of C&D materials. There is also a need to continue to work with Mn/DOT on market development for recycled aggregates. Market development is a critical area.

There is a widely held view by stakeholders that generators should take an active role in increasing recovery rather than requiring disposal facility operators to recover materials. Several of the management options noted above can be used as means to create incentives for generators.

To achieve the C&D material recovery requires much more processing capacity than is currently available in Minnesota. Identifying means to stimulate the development of C&D processing capacity is an important government role.

A combination of management options from the educational, economic, and enforcement strategies should be pursued as a comprehensive package. Potential combinations include:

8.2.1 Market Development

- ◆ Generic
 - ▶ Adopt a comprehensive market development plan for C&D materials. This plan should include more details on costs and benefits, including resource conservation benefits (e.g., energy savings, green house gas emissions savings, etc.)
 - ▶ Goals for C&D waste diversion can provide positive signals to the private sector.
 - ▶ Clear priorities will help focus government resources and signal to the private sector the general timing of work on specific commodities listed below.
- ◆ Shingles
 - ▶ Continue and expand County – Mn/DOT-MPCA collaboration towards adoption of a new state materials specification providing for the appropriate use of tear-off recycled asphalt shingles in hot mix asphalt (HMA).
 - ▶ Continue to monitor and support industry developments on other higher value end use applications (e.g., as a fuel supplement in cement kilns, as a boiler fuel supplement, as aggregate for new shingles).
 - ▶ Implement best practices for affirmative state and local government HMA procurement policies to offer incentives and market signals to use tear-off RAS.
 - ▶ Develop a targeted grant and loan program for new business development of tear-off shingle recycling operations.
- ◆ Biomass fuels
 - ▶ Promote combining waste management policy and renewable energy development.
 - ▶ Support development efforts for several biomass facilities under consideration such as for Rock-Tenn and Minnesota Power.
- ◆ Glass
 - ▶ MPCA should continue to refine glass marketing policies. For example, how should the State encourage best and highest use; specifications for use as alternative daily cover (ADC) at landfills; need for beneficial use determinations when used as an aggregate supplement; and/or additional leadership needs; etc.
 - ▶ Glass market development efforts need further State and local government assistance.
- ◆ Wallboard
 - ▶ Facilitate research efforts for markets such as new wallboard, Portland cement manufacture, soil amendment, and compost amendment.
 - ▶ Consider pilot and demonstration projects.
 - ▶ Consider pursuit of product stewardship approaches for wallboard manufacturers.

- ◆ Aggregate
 - ▶ Continue to work with Mn/DOT to improve recycled aggregate specifications.
- ◆ ADC
 - ▶ MPCA should continue to refine a larger, more comprehensive policy on the issue of residuals from mixed C&D recycling use as ADC. All stakeholders should be notified of MPCA's intent for such a policy review.

8.2.2 Generator Incentives

- ◆ Sustainable building guidelines such as LEED™
 - ▶ Standardized materials management definitions and C&D recycling measurement guidelines
 - ▶ New, independent C&D recycling certification programs.
- ◆ Government sponsored technical assistance services
 - ▶ Patterned after much of the reduction/recycling assistance provided for MSW
 - ▶ Promotion of sustainable building guidelines
 - ▶ Promoting deconstruction and pre-demolition practices
 - ▶ Promoting numerous best practices via networking, workshops, and forums for designers, developers, contractors, etc.
- ◆ Develop financial incentives
 - ▶ Dedicate current C&D and industrial waste taxes to promoting material recovery
 - ▶ Expand SCORE grants to explicitly cover C&D related recycling activities, especially investments in the end use and processing infrastructure
 - ▶ Pursue having some municipalities implement tools applicable to their level of government such as:
 - ◆ Building/demolition permit deposits with funds returned for documented recycling and recovery
 - ◆ Ordinances requiring recycling as part of certain size projects (similar to city of Chicago system or some variation)
 - ◆ Promote the results of these “demonstration” projects to other municipalities
 - ◆ Affirmative procurement strategies (e.g., purchase of HMA derived from tear-off shingles)
- ◆ Set diversion goals (reduction and recycling) specific for C&D
 - ▶ Document current diversion levels so that goals are set at proper levels and monitored appropriately
 - ▶ Use all the other tools within the options to facilitate reaching the goals

8.2.3 Promotion of C&D Processing

- ◆ Several of the generator incentive concepts above will contribute to the development of C&D processing capacity.
- ◆ Make CAP grants available for C&D processing.

- ◆ Develop other grant and loan programs for targeted market infrastructure development allowing private companies to be directly eligible recipients.
- ◆ Consider a statewide, mandatory C&D processing requirement for projects above a certain size (larger than single-family residential or small commercial). This approach would likely facilitate private companies to invest in facilities to provide the processing service.
- ◆ If voluntary efforts to meet C&D goals are not successful, consider adoption of mandatory goals, especially for materials with well-established markets.