Deconstruction in the City of Tacoma, WA: A Case Study

By
Stephanie D. Gowing

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[sgowing@gmail.com]

This Thesis for the Master of Environmental Study Degree

By

Stephanie D. Gowing

Has been approved for

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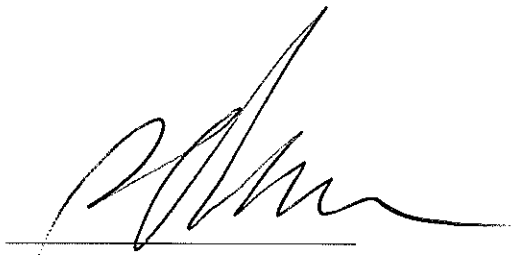
By



Peter Dorman, PhD.

Member of the Faculty

April 27, 2010

Date

ABSTRACT

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OBJECTIVES: Deconstruction is defined as the disassembly of structures for the purpose of reusing components and building materials (NAHB, 1996). The primary intent is to divert the maximum amount of building materials from the waste stream. Webster's dictionary defines waste stream as aggregate flow of waste material from generation to treatment to final disposition. Deconstruction can significantly decrease the national solid waste burden placed on the environment by the construction industry, by fostering local economic growth, increasing employment and training opportunities and saving natural resources by diverting materials from landfills. Deconstruction supplies useful building material stock to building materials yards, recycling centers and remanufacturing enterprises; this also creates jobs and community revenue. This report focuses existing deconstruction polices in five selected U.S. cities. An inventory is then investigated in light of their applicability to the City of Tacoma, WA.

METHODOLOGY: A comparative case-study was used to analyze barriers and strengths of deconstruction incentives in U.S. cities. This review helped develop the factors that influence implementation of deconstruction in the City of Tacoma. An inventory such as this could facilitate how Tacoma can overcome its barriers to deconstruction success.

RATIONALE: Significant economic and environmental opportunities can evolve from better management of construction and demolition (C&D) waste components in the City of Tacoma. This paper will report on technical, economic, and policy issues related to deconstruction incentives, and will determine the constraints, opportunities, and procedures involved in establishing building deconstruction incentives with the intent to salvage building materials for reuse. Several case studies from U.S. cities prove that deconstruction is an economically and ecologically viable alternative to demolition and subsequent land filling.

The U.S. EPA reports that 92% of C&D waste is a result of renovation and demolition (Franklin Associates, 1998). In Washington State, relatively low tipping fees and high rates of growth and development have contributed to the magnitude of C&D waste generation. A city's population growth pushes the construction industry to provide infrastructure, which in turn increase C&D waste. Approximately 34% of the municipal solid waste created in Washington State can be attributed to C&D waste (DOE, 1999). Use of reclaimed building materials is an under-researched and rarely implemented strategy for waste reduction. The environmental impacts of demolished structures and their associated economic losses can be diminished through targeted materials reuse. Salvaged items can become value-added products through reuse or recycling with minimal added energy inputs. Consequently, lack of a recovery, reuse, and recycling infrastructure contributes to excess waste and environmental degradation. Implementing recovery and reuse will ultimately lessen the solid waste management burden and reduce environmental degradation. Stakeholder input (deconstruction and reuse companies, architects, builders, regulators, code enforcement, and institutional users) provides an understanding of the economic, technical, and practical considerations underlying the use of salvaged building materials for private and commercial applications. The U.S. cities with deconstruction policies analyzed in this report have generated field research data through case studies.

Encouraging revitalization and redevelopment of older communities can provide significant savings for local and regional governments while providing a setting conducive to the implementation of deconstruction. Sprawling development requires more roads, longer sewer lines, and other infrastructure to serve it. The process of infilling (building on vacant lots within the existing city fabric, instead of expanding the city into new land) could assist in promoting deconstruction as it often requires renovation. As virgin property disappears, developers will look to demolition and renovation of outdated structures to support the influx of new residents. The implementation of deconstruction allows Tacoma to continue experiencing growth without compromising the quality of life experienced by existing and future residents. Deconstruction will also create new industries to support further economic growth.

Tacoma's Office of Sustainability (resolution 37631) can provide the resources and framework for establishing such initiatives, working directly with Tacoma's Public Works Department.

KEY FINDINGS

In communities throughout the United States, required recycling and incentive strategies for the commercial and construction and demolition debris waste streams have been successfully implemented. Key findings of the programs profiled in this report include critical elements that established their programs. After reviewing an inventory of possible program elements, contextual recommendations to barriers facing Tacoma recommendations are provided. These include increasing warehouse space, educating all stakeholders involved, enforcing a waste diversion plan, and strengthen green building policy.

ACRONYMS

C&D Construction and Demolition

DfD Design for Deconstruction

W&D Waste and Diversion

GHG Green House Gases

LEED Leadership in Energy and Environmental Design

NAHB National Association of Home Builders

CFR Code of Federal Regulations

$MTCO_2E$ Metric Tonne (ton) Carbon Dioxide Equivalent

SWAC Solid Waste Advisory Committee

ILSR Institute for Local Self-Reliance

ACM Asbestos-Containing Materials

PSAPCA Puget Sound Air Pollution Control Agency

USHUD Department of Housing and Urban Development

SWM Solid Waste Management

CDL Construction Demolition & Land-clearing debris

AHERA Asbestos Hazard Emergency Response Act

NAIOP National Association on Industrial and Office Properties

ABC Asphalt, Brick, and Cement

PRC Public Resource Code

CIWMB California Integrated Waste Management Board

CDDD Construction Demolition Debris Deposit

ADC Alternative Daily Cover

Table of Contents

List of Tables

List of Figures

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Introduction

A 92-year-old craftsman bungalow near the corner of South 17th Street and Martin Luther King Jr. in Tacoma, Washington has seen better days. The house is an eye sore with cracked windows, a dilapidated front porch, chipped paint and an overgrown yard engulfing the property. In August 2008, it was determined to be demolished. Instead, Morgan Alexander, a preservationist who once served on the board of directors of the Historic Tacoma committee, offered a different solution: deconstruction. Alexander helped connect the property owner with a local recycling company to salvage some of the building materials. Soon afterwards, workers from the Metropolitan Development Council's ReHarvest Center were busy removing materials. As Alexander explains, "the thing with deconstruction is that the cost is actually about the same as tearing it down and throwing it in the landfill. But there are not really any incentives or rewards for deconstruction. Right now, it's kind of a backward policy at the City that has unintended side effects. The challenge is going to be to come up with a way to create incentives to encourage more deconstruction as opposed to demolition and trucking to landfills" (Mathews, 2008 and pers. comm. Morgan Alexander 3-06-2009).

In 2002, 34% of Washington State's transferred waste was attributed to C&D waste (Department of Ecology, 2008b). According to the state Office of Financial Management, the population of Washington is projected to see an increase of 2.34 million people by the year 2030 and waste generation is predicted to increase at an even greater rate. The City of Tacoma received 182,559 tons of garbage in 2008 (pers. comm. Michelle Warmuth, Solid Waste Community Relations 9/8/2009), but does not currently track construction and demolition (C&D) waste separately. Land Recovery Inc. (LRI), Tacoma's contracted landfill provider, reported 68,558 tons of C&D waste in 2007 (Department of Ecology, 2008a). Although Tacoma did not generate all 68,558 tons, the city contributed a significant portion[1]. Studies indicate that deconstruction can reduce construction site waste by 50 -70% (Browning *et al*., 2006). This not only helps extend the life of the existing landfills, but also reduces disposal costs for developers because it minimizes the amount of building related C&D material that they are responsible for disposing at the end of a project. As the need for landfill space increases, so do environmental injustice concerns for new development needs, energy consumption, and environmental degradation such as hazardous chemical leaching.

[1] Due to the lack of tracking, definitive values are hard to locate.

The deconstruction, recycling and reusing sector can create employment opportunities because deconstruction is a labor-intensive process (Kibert and Languell, 2000; Macozoma, 2001; Liu et al., 2003a). "Green Jobs"[2] in the building deconstruction sector, are a topic of continual discussion by elected representatives at the state and federal level. The City of Tacoma and Pierce County are facing high unemployment rates (Gillie, 2009) that could be lowered if deconstruction jobs became available. The need for substantial work in the City of Tacoma to create deconstruction job opportunities is discussed further in Section 3.2.

Climate action plans for reducing greenhouse gas (GHG) emissions are also on the forefront of political discussions, as State and City leaders establish GHG emission goals and regulatory language. Deconstruction reduces the total expenditure of energy involved in the creation of buildings and its constituent materials, including extraction of raw materials, their manufacture into building materials, transportation to building sites, and the equipment and tools used to assemble the materials (Frisman, 2004). Deconstruction fits well into climate action plans as the process itself uses low levels of GHG.

Driven by the need to comply with State waste diversion mandates, improve the job market, and create climate action protocols, some local governments are targeting single-source waste streams[3] with a high potential to divert waste. Construction and demolition (C&D) waste is considered a "priority" solid waste. Although there are regulatory approaches for increasing C&D waste diversion with local level waste ordinances, diverting waste by using incentives for deconstruction is a fairly new initiative.

In the past 10 years, numerous cost benefit analyses have been conducted to assess the environmental, economic, and social impacts of deconstruction (Rousatt *et al*., 2009, Crochen *et.al,*. 2007, National Association Home Builders Research Center, 2001). When viewed individually, each case yields unique results. However, when the results are combined, they yield a comprehensive list of the many benefits that deconstruction offers. Deconstruction has become a viable alternative to demolition and should be incentivized at the local level.

This paper analyzes case studies from five cities, examining the success and implementation of deconstruction incentive initiatives. These case studies provide examples of how incentives can be

[2] Building deconstruction is seen under the green building sector in the "green economy" according to the Department of Community, Trade and Economic Development (CTED). Definitions are required from Engrossed Second Substitute House Bill 28152, approved by Governor Gregoire and the Washington State Legislature in 2008.

[3] Source Reduction is an action which causes a net reduction in the generation of solid waste

influential in overcoming social and economic barriers to deconstruction**.** After the case studies are analyzed, each will be compared to the City of Tacoma's characteristics and any applicable incentive initiatives will be assessed in terms of how they can be implemented by the City of Tacoma. **This inventory will highlight components that are pertinent in the successful implementation of deconstruction incentives and how these initiatives can be applied to the City of Tacoma.**

This analysis begins with a definition of deconstruction and its impact on sustainability (which will later be defined) then summarizes the main benefits of deconstruction. Known barriers to deconstruction, and which barriers apply specifically to the City of Tacoma, are then presented. The main section of this paper examines how some barriers have been overcome in other city programs, specifically Portland, Oregon; Seattle, Washington; San José, California; Boulder, Colorado; and Chicago, Illinios. Lastly, this paper makes recommendations on how the City of Tacoma can overcome its deconstruction barriers with the goal of improving deconstruction program processes and regulations.

1. Deconstruction Defined

Currently, most structures are demolished in the reverse order of their construction; demolition contractors either gradually decrease the height of the building or plan a controlled building collapse. Controlled building collapse is typically accomplished by one of the following methods: 1) piecemeal demolition using small tools and equipment, or 2) planned collapse or demolition by machine (Lease et al., 2002). Unlike demolition, which focuses on dismantling existing buildings with speed and efficiency, deconstruction involves the careful disassembly of building components with the key purpose of reuse. Deconstruction has often been described as "construction in reverse", the systematic disassembly of residential and commercial buildings resulting in the generation of materials suitable for reuse. The National Association of Home Builders (NAHB) defines deconstruction as "a process of selective dismantling and removal of materials before demolition" (NAHB 1996).

Deconstruction aims to maximize the amount of valuable materials recovered from buildings for reuse and recycling (Shami, 2006). There are two distinct types of deconstruction: non-structural and structural. Non-structural deconstruction, also known as soft-stripping, is a method that demolition contractors have practiced for years, primarily for the immediate financial benefits. Although many demolition projects already incorporate some non-structural deconstruction activities, there is room for the conventional demolition industry to integrate this practice more broadly. Structural deconstruction consists of involved recovery activities that require more effort and resources to implement then non- structural. To offset the costs of these activities, projects aim to salvage higher value materials. A complete deconstruction project

would undertake both structural and non-structural methods (US EPA 2008). Table 1 further describes these deconstruction types.

Table 1.Non-Structural and Structural Deconstruction

Deconstruction Type	Description	Characteristics	Types of Salvaged Material
Non-Structural (i.e. soft stripping)	The removal for reuse of any building contents that do not effect the structural integrity of the building	• Requires less planning and coordination that structural deconstruction • Materials can be viewed and removed without much destructive access • Uses few tools and materials are savaged relatively easily with minimal safety concerns • Does not have a significant effect on project schedule	• Finish floor • Appliances • Cabinetry • Window/doors • Trim • HVAC equipment • Fixtures/hardware • Fireplace mantels
Structural	The removal for reuse of building components that area integral part of the building, or contribute to the structural integrity of the building	• Involves a range of tools and mechanization • Heighted safety consideration, and longer time-frame • Materials removed are typically large, rough products that are reused as building materials or remanufactured into value added products	• Framing • Sheathing • Roof Systems • Brick/Masonry • Wood timbers/beams • Wood rafters • Floor joist system

Source: U.S. Department of Housing and Urban Development (2000); National Association Home Builders Research Center (2001)

As a process, deconstruction can be considered in one of these three scenarios: 1) occurs prior to ordinary demolition; 2) a vital phase within the demolition process (hybrid); or 3) entirely replace demolition (Path, 2000). Assessing which method of deconstruction is appropriate for a particular project, depends on the type of building and its components. According to the Department of Housing and Urban Development (USHUD), highly deconstructable buildings are wood framed, contain specialty material, have high quality brick laid construction with low-quality mortar, and are structurally sound. Deconstruction is not encouraged when buildings contain a lot of adhesives, composites and laminates.

Understanding the legislative and regulatory context affecting deconstruction is relevant to understanding waste management responsibilities and its effect on the built/unbuilt environment.

2. Legislative and Regulatory Factors Affecting Deconstruction

Washington State law assigns primary responsibility for collection, transfer, and disposal of solid waste (including prevention and recycling) to local (i.e., county, city) governments (RCW 70.95). The State gives municipalities exclusive authority to provide and set rates for solid waste services by using municipal workers, competitively bidding contracts to private companies, or developing inter-local agreements with a county or city to provide services (RCW 35.21).

The Washington State Legislature amended RCW 70.95.305 and reenacted and amended RCW 70.95.020 in July 24, 2005. The Act dealt with the flow control issue of C&D waste (SB5788 and HB1817 respectively) by stipulating that: 1) as long as independent recyclers did not take recyclable C&D wastes directly to a landfill, but took them to permitted recycling processing centers, then the public interest of health and safety and recycling goals were being served; and 2) a separate container for solid waste would be provided at all sites from where recyclable materials are generated and transported (Herrera Environmental, 2007). Under Tacoma's municipality Code 12.09.120 (H), the City can provide roll off box service (DOB) for a $50 delivery fee and $50 haul charge plus $2.50 per mile one way to the recycling facility.

The abatement and disposal of asbestos-containing materials (ACM) in C&D waste is regulated under Washington State Dangerous Waste Regulations (WAC 173-303), under Article 10 of Regulation No. 1 of the Puget Sound Air Pollution Control Agency (PSAPCA), and by the U.S. Environmental Protection Agency (EPA) (40 C.F.R., 61 Subpart M). The Tacoma-Pierce County Health Department does not review disposal of common asbestos waste, nor does the City have specific ACM regulations aside from acceptance requirements. These regulations are intended to protect worker and public health safety while

preventing unsafe disposal or release of ACM into the environment. A potential consequence of these regulations is that contractors and homeowners may incur additional project costs and/or delays of remodeling or demolition projects when ACM are present; this may discourage salvage or deconstruction.

The potential to recycle C&D waste materials is also affected by the presence of lead-based paint (LBP) in building materials removed from structures built prior to the 1980s. Disposal of materials containing LBP is regulated by the EPA (40 CFR Parts 257 and 258). In 2000, the EPA issued a policy statement allowing contractor-generated LBP waste to be disposed of as household waste with the intention of simplifying abatement work, reducing contractor costs, and accelerating the removal of LBP from more homes nationwide.

As of October 2009, there is no resolution goal for the City of Tacoma, specifying C&D waste reduction. Historic Tacoma, a 501(c)(3) nonprofit organization, has discussed deconstruction issues with Tacoma's Environmental and Public Works Committee. Councilman Jake Fey, who chairs the committee, assured the organization that deconstruction will be included in the City's strategy to deal with solid waste/landfill issues (pers. comm. Sharon Winters, Board President of Historic Tacoma 4/4/2009). The City of Tacoma has verbally expressed the importance of deconstruction and is trying to determine the best approach for implementing a successful resolution.

3. Deconstruction and Sustainability

Our nation, state, and cities have an environmental responsibility to continuously improve the construction, renovation, and demolition process. One such sustainable improvement is deconstruction. According to the National Association of Home Builders (NAHB), the size of an average home in the United States jumped 45% between 1970 and 2002, from 1,500 to over 2,200 feet^2, while the number of people living in each home decreased from an average of 3.2 to 2.6. If present trends continue, demolition and renovation of older structures will need to increase to allow for new and larger structures.

There are social repercussions, as well as economic impacts and ecological effects, to what is built and how it is built (Franklin Associates 1998). Resource use and environmental degradation continue to be an inevitable byproduct of our existence. More recently, it has been heightened by developing new sites, maintaining, and renovating occupied sites. It is important that design professionals and other members of the building construction industry remain collectively focused on and committed to preserving the environment. This type of collective focus and commitment requires continuous dialogue amongst all participants involved in the production of the built environment. Innovative environmental buildings

reflect changes in the process and their creation, as well as their distinctively different design features and characteristics. Environmentally responsible building design involves challenging existing design norms and promoting a shift in attitude to embrace new ways of thinking about the processes over the life of a building.

Changes in environmental policy and attitudes have fostered new developments in solid waste management and environmental preservation; the effective slogan "Reduce, Reuse and Recycling" (as seen in Section 4.1) is an example of this. Incorporating deconstruction into reducing, reusing and recycling of materials will require at *least* three key elements: knowledge, incentives, and coordination. The City of Tacoma has begun coordinating how sustainability should be addressed within the government and community by committing to the reduction of greenhouse gas emissions. When Tacoma's Mayor, Bill Barrasma, signed the U.S. Mayor's Climate Protection Agreement in April 2005, he pledged that the City of Tacoma would strive to meet or exceed the reduction target set in the Kyoto Protocol to cut emissions by 7% from 1990 levels by 2012. In April 2006, the Tacoma City Council adopted a resolution supporting efforts to curb global warming and reduce greenhouse gases, while encouraging the continued growth and development of clean technology businesses in the City of Tacoma (Resolution 37631). The resolution called for reducing greenhouse gas emissions in City operations, while pursuing reductions in community emissions through cooperative programs and policies (Green Ribbon Task Force Report 2008).

The Green Ribbon Climate Action Task Force was established by Tacoma's City Council in February 2007. The Task Force was charged with defining carbon reduction goals and developing specific community and government action plans to achieve those goals and review Tacoma's emissions inventory. Task Force members identified more than 80 strategies to reduce greenhouse gas emissions, including 40 new strategies. The Task Force gathered public feedback on the proposed strategies through a series of public meetings and from a Web-based survey. After reviewing all of the feedback, the Task Force adopted its final recommendations in May 2008.

Two subcommittee recommendations from the Task Force's Built and Un-Built Committees coincide with deconstruction and its impact on sustainability. The first recommendation was to provide incentives and remove barriers for green building. This included identifying and implementing improvements and changes to its codes and policies related to new and remodeled structures to accomplish the following:

Adaptive reuse of historic or older buildings should be encouraged through City policy and codes.

- Perform an analysis of the City's current codes, policies and administrative processes to determine if there are institutional barriers to green building in the City of Tacoma.
- Identify and report to the City council methods to provide incentives for green building in Tacoma, including such items as quicker review times for permits, reduced permit fees, and tax abatements.
- Research and identify ways to partner with existing and future private and Non-Governmental Organizations green building programs such as Built Green and the upcoming National Association of Home Builders Standards. Methods to leverage City and Private sector efforts to streamline these efforts should be explored.
- Recommend the City Council pass an ordinance that requires all new and remodeled Government buildings, or buildings which receive public funds from Federal, State or local governments, to be built to LEED[4] Silver certification or higher. An alternative standard can be applied if the alternative standard is developed to ensure that the buildings are designed, built and operated in a sustainable manner equal to or greater than LEED Silver certification.
- An alternative standard to LEED shall be developed in the form of a policy and checklist or similar standard that would identify minimum sustainability requirements for City built structures.

The second subcommittee recommendation regarded solid waste policies, its efficiencies and waste reduction. It was recommended that methods be adopted to encourage deconstruction and recycling of structures to be demolished in the City of Tacoma, keeping in mind the City's goal (Green Ribbon Task Force Report 2008) to reduce annual waste by 16,000 tons by the year 2020.

Deconstruction is a new strategy for Tacoma that will improve local and regional sustainability efforts and reduce environmental degradation. It will reduce GHG emissions that go into new building material (the built and un-built impacts) and create immediate reuse of materials. Deconstruction keeps existing materials in circulation and out of landfills (solid waste impacts), making it a significant advancement toward a sustainable environment. Some of the Green Ribbon Climate Action Task Force's recommendations are discussed further in cases analyzed in this paper. Cities are initiating built green options and deconstruction/waste diversion mandates to facilitate numerous social, economical, and environmental benefits through deconstruction.

[4] The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system is the preeminent program for the design, construction and operation of green buildings. 35,000 projects are currently participating in the LEED system, comprising over 4.5 billion square feet of construction space in all 50 states and 91 countries.

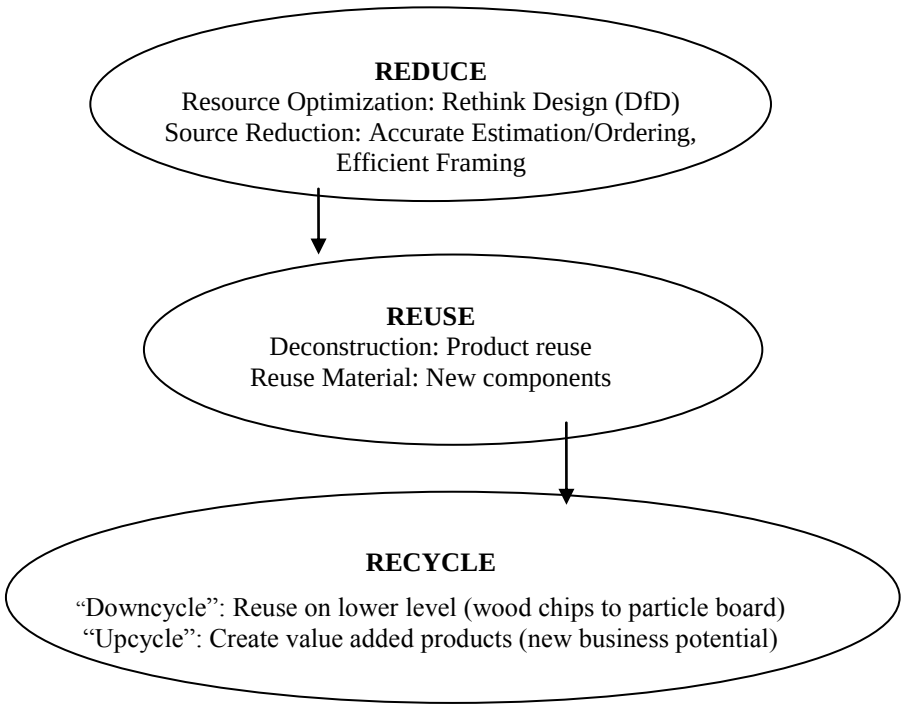
4. Known Benefits of Deconstruction

Deconstruction is becoming a complement to or a substitute for demolition worldwide, including in the U.S. where a market is emerging. In 2008 over 250 active deconstruction programs were reported throughout the U.S. (US EPA, 2008). Such programs recognize the potential benefits of deconstruction which include reduction of waste and debris, economic enhancement, historical preservation, resource conservation, and community support and revitalization. These benefits can be experienced by the City of Tacoma, once better waste management components are established and constraints to deconstruction are well understood.

4.1 Reduction of Waste and Debris

According to the Deconstruction Institute, resource efficiency will have to increase by a factor of 10 in order to sustain human society into the next century (US EPA, 2008). The materials salvaged through deconstruction help replenish the construction materials market, rather than add to the amount of waste in landfills. This is accomplished through the coined waste management reduction phrase, "Reduce, Reuse, and Recycle," represented in Figure 1 and discussed below.

Figure 1. Deconstruction and its place in "reduce, reuse, and recycle"



4.1.1 Deconstruction and "Reduce"

Multiple factors work together to create a groundswell of support for deconstruction as an integral component of a "lifecycle" approach to building construction, including a growing consumer interest in "greener" buildings as well as state and local initiatives to address the large volumes of C&D materials entering the waste stream. A broad definition of lifecycle construction is: "the design of building materials, components, information systems, and management practices to create buildings that facilitate and anticipate future changes to and eventual adaptation, disassembly, or dismantling for recovery of all systems, components, and materials" (US EPA, 2008). This definition should not be mistaken for a one-size-fits-all prescription for future building projects, but rather be seen to represent a set of principles that can transform the way we think about, create, and modify our built environment; inevitably what we can *reduce* in our built environment.

4.1.2 Deconstruction and "Reuse"

Reuse is the most desirable option in deconstruction because it is the most effective in reducing the demand for virgin resources and reducing waste (Webster and Bronski, 2005). Reuse or salvage (this paper will use the terms interchangeably), means the reuse of a previously used item (i.e. brick, a piece of lumber, steel columns) with minimal processing. Contrast reuse with post-consumer recycling, wherein a used product is destroyed to manufacture a new, similar or different product. Reuse means using a product over and over again until it wears out. The philosophy of reuse isn't unique to America's history, but as a greater number of consumers participate in the global economy, the demand for convenience and export packaging is overriding reuse philosophy. Many areas around the globe lack organized systems for trash collection, recycling facilities and methods of resource distribution; missing these infrastructures negatively impacts quality of life. Reducing waste by applying the reuse philosophy will help to sustain our comfortable quality of life, enhance it for others, and maintain it for future generations.

4.1.3 Deconstruction and "Recycle"

There are a small, but growing number of companies working hard to develop C&D recycling markets and create high-value recycled content products (Beatty, 2009). Government and nonprofit agencies are devoting significant resources to facilitating the recycling and salvage of various materials from roofing to flooring (Beatty, 2009). This is illustrated by concrete. Once concrete is no longer in its original form, it can create aggregate used for filling roads, create new forms and uses, and can be mixed with fly ash. Fly ash is an affordable and durable alternative to Portland cement. Fly ash is a fine, glass-like powder recovered from gases created by coal-fired electric power generation. NAHB researchers have measured

the diversion of materials from final disposal in a landfill (termed diversion rate) of buildings due to recycling efforts. The diversion rate for buildings has been found to reach as high as 76% by weight and 70% by volume (Franklin Associates, 1998). Recycling C&D material can have a significant impact on our waste stream.

It is important to establish C&D waste management plans that incorporate all coined aspects of "Reuse, Reduce, Recycle", and assess them interdependently. This will help to improve tracking viable options, targeting C&D waste types, and record keeping. Tracking data only for recycling will not sufficiently monitor progress. For instance, Washington's recycling rate has increased between 3% – 4% per year over the last four years. Unfortunately the disposal rate has also increased over the last few years. In 2004, the waste disposal rate for Washington State increased by approximately 24% to 7,418,978 tons (Tross, 2007). This could signify a decrease in reuse diversion.

4.2 Economic Benefits

According to the Institute for Local Self-Reliance (ILSR[5]), many people perceive deconstruction to be more costly than demolition. However, data gathered and analyzed by ILSR found that trained workers could deconstruct a building at $2 per square foot, while demolition costs about $3 per square foot. Results have also shown that the time required and cost of deconstruction can be reduced by more than 50% if various project planning models are used (Schultmann, 2002). In order for deconstruction to be cost-effective and competitive with traditional methods of demolition and disposal, the sum of savings from disposal and revenues from resale of materials must be greater than the incremental increase in labor costs. Ensuring that a building's materials are worth salvage, having efficient resale mechanisms and markets, and decreasing processing effort will increase the percentage of time available to spend on deconstruction activity, thus decreasing time costs overall.

Since deconstruction generates less waste than mechanical demolition, tipping fees are reduced. Tipping fees at landfills have increased dramatically in recent years (Manuel, 2003). In the U.S., fees increased from an average of $9.09 to $38.60 per ton between 1985 and 1996. In some urban areas, such as San Francisco, tipping fees can reach $110.00 per ton (Kibert and Chini, 2000). In the City of Tacoma, the tipping fee is $50.00 per ton. The increase in tipping fees and the opportunities to stimulate the economy by creating jobs is slowly developing a market for deconstruction. However, low tipping fees remain one of the biggest challenges to reducing C&D waste (Beatty, 2009).

[5] http://www.ilsr.org/recycling/decon/deconatwork.html

Many of Tacoma's organizations and businesses exemplify successful salvage and recycling markets; this supports the argument that that there is a viable market for deconstruction in Tacoma. Tacoma's ReStore is a 501(c)(3) non-profit organization providing substantial tax deductions for donated building materials. This can significantly offset costs of deconstruction. Private companies in Tacoma, such as R.W. Rhine, have some of the largest used timber and piling yards in the Northwest (R.W. Rhine website accessed 4/5/2009). Both Recovery 1 and Resource Woodworks in Tacoma have established successful salvage and recycling markets from deconstruction (and demolition) activities. Tacoma's Metropolitan Development Councils' ReHarvest Center offers training to work crews to extract salvageable materials from buildings slated for demolition. Training in this process provides new employment opportunities.

4.3 Historical Preservation

Many buildings slated for deconstruction contain historic materials such as moldings, doors, mantels and other architectural features that can be used to beautify other buildings and preserve architectural history. Deconstruction promotes preservation because it supports the maintenance necessary to continue a building in its present state and to prevent deterioration. Maintenance needs for buildings of a certain era require specialty items found in the salvage market. This encourages the reuse of products, conservation of historical buildings, and structures that are culturally, architecturally, or environmentally significant.

4.4 Resource Conservation and Emissions Reduction

Through deconstruction and reuse of materials, the amount of waste deposited in landfills is significantly decreased, reducing GHG emissions. Using the U.S. EPA's Waste Reduction Model (WARM)[6] to estimate greenhouse gas reduction, the zero waste approach,[7] as compared to the business-as-usual approach, would reduce greenhouse gases by an estimated 406 megatons CO_2 eq. per year by 2030. This reduction of 406 megatons CO_2 eq. per year is equivalent to closing 21% of the nation's 417 coal-fired power plants (ILSR, 2008). Implementing deconstruction practices also reduces the amount of embodied energy emitted during the processing of virgin resources as it reduces the use of virgin resources.

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[6] http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

[7] Berkeley, Los Angeles, San Francisco, Seattle and Austin, Texas, are some cities that have implemented zero-waste goals. "Zero waste" means something different in each of these communities, but the essential goal is the same: dramatically reduce the amount of landfilled waste and benefit the environment.

Deconstruction would allow for a reduction of GHG emissions by 900,000 $MTCO_2E$ per year from recycling carpet and padding alone (SWAC meetings minutes 7/15/2008).

4.5 Community Support and Revitalization

Perhaps most importantly, deconstruction helps steer the C&D industry away from traditional consumption and disposal patterns and towards sustainability and reuse. When deconstruction and use of salvage materials are used, the philosophy of "waste not, want not" is supported and the positive effects resonate for generations. The majority of people support the preservation of materials and concept of reuse, which can revitalize a community and bring people together. In a study on post Katrina New Orleans victims, (Denhart, 2009) participants reported a sudden psychological shift from despair to enthusiasm as they regained control of their property and then discovered value in ruined buildings. Data indicated that merely possessing reclaimed material did not explain the psychological transformation. Four of nine informants (including impoverished individuals) experienced psychological transformation by giving all of their reclaimed material away. The sharing of material was described as asking to "donate organs," giving life to their critically injured community.

If deconstruction results in the reduction of waste and debris, economic opportunities, historical preservation, resource conservation, and supports community revitalization, why isn't it occurring more frequently in the City of Tacoma? Section 5 discusses identified constraints to deconstruction (in general) as well as key binding constraints specific to the City of Tacoma.

5. Deconstruction Barriers

An analysis of waste composition from various industrial and commercial demolition projects found that more than 90% was reusable and less than 10% should be sent to landfills (Franklin Associates, 1998). This large percentage identifies that deconstruction must have buil-in disincentives. Research conducted by the U.S. Department of Housing and Urban Development (USHUD) (NAHB, 2001) investigated the feasibility of deconstruction in four major U.S cities: El Paso, TX; Miami, FL; Milwaukee, WI; and Nashville, TN. This study found that the major concerns impeding the adoption of deconstruction in buildings include:

- Project time restraints,
- Lead-based paint,

- Code issues,
- Export markets,
- Housing preservation,
- Asbestos-containing materials,
- Used building materials markets and the internet,
- Market perception of used building materials, and
- Alternative applications for used building materials.

The City of Seattle commissioned Herrera Environmental to conduct 28 interviews on barriers to increasing salvage, deconstruction and recycling activities (Herrera Environmental, 2007). This study found that major barriers *not mentioned* in the above HUD (2001) study, included:

- High labor and insurance costs,
- Warehouse space, and lack of centralized locations where people can take salvaged material,
- Non-uniformity of material such as lumber, and material that do not meet current engineering specifications[8], and
- Transfer station personnel lack of knowledge on deconstruction and salvage.

Many of the concerns above are also barriers to the City of Tacoma's deconstruction efforts, and some have not been addressed in major surveys. Specific barriers that Tacoma faces that will be discussed in more detail in this report include:

1. Lack of warehouse space,
2. The market perception of used building materials in Tacoma,
3. Requirements to oversee improper disposal (shaming) and the challenges of not having a city regulated waste diversion plan, and
4. The lack of green building incentives.

These four barriers will be discussed in turn below in light of their effect on deconstruction in the City of Tacoma. Later, deconstruction programs in various U.S. cities will be presented as examples of how these

[8] Building practice revolves around satisfying codes, and codes for safe structures typically call for very strong assurance that materials will be strong enough for their application. Non-uniform materials require an expert to look at each piece and make a professional judgment. This is much slower and more expensive than with uniform materials.

barriers may be overcome, and provide a possible framework for a deconstruction policy in the City of Tacoma.

6. Barriers to Deconstruction Specific to Tacoma, WA

Solid Waste Management (SWM) has evolved considerably since 1929 when the City of Tacoma acquired the exclusive franchise rights and responsibilities for garbage collection and disposal (Tross, 2007). SWM is responsible for three applications with a goal to divert less C&D waste. One is Tacoma's showcase house, called Enviro House which presents green building ideas, materials and techniques for the public. The other two include Tacoma's 2Good2Toss online reuse program and their agreement with Goodwill Industries and Habitat for Humanity at the landfill site. Solid Waste Management presented their strategic business plan mission (2007-2012) on implementing a more integrated and sustainable solid waste management program that is environmentally safe and economically and technically feasible. Unfortunately, the SWM plan does not consider nor discuss deconstruction.

SWM has developed a waste reduction plan to reduce residential and commercial garbage by 39% to 118,000 tons, and increase recycling by 101% to 102,000 tons by 2024 (Tross, 2007). This plan supports Washington State's "Beyond Waste" plan and Pierce County's Solid Waste Management plan. Solid Waste Management intends to achieve this goal by expanding waste reduction opportunities through new and improved communication about existing programs and services and recycling programs. These programs include construction, demolition and deconstruction materials.

In order for SWM to be successful in reducing C&D waste to comply with the "Beyond Waste" plan as well as Tacoma's GHG emission reduction goals, Tacoma must assess barriers to these goals and look outside the waste management facility. The Office of Sustainability is the perfect liaison to facilitate the public works division in all the services that may be affected by demolition/deconstruction such as the building and land use codes services, waste management services, and real estate services.

6.1 Lack of Warehouse Space

One barrier to deconstruction is the lack of warehouse space to store and separate valuable salvaged goods. The City of Tacoma has discussed expanding their 240 acre landfill by adding an additional transfer station to facilitate separating recyclable construction material from garbage. Although the

transfer station project is moving forward, it most likely will not be a collection site to house salvageable construction waste (pers. comm. Bill Smith 5/11/2009). The landfill facility is designed to give first and foremost access to the recycling area, prior to the weighed station to dump (see large covered building in Figure 2). At the recycling station, both Goodwill and ReHarvest collection receptacles are available for material drop off. An agreement with Tacoma Goodwill Industries collects household and office furniture, electronic equipment, tools, etc., and ReHarvest has an attended donation station at the recycling station for reusable building materials. The success of creating additional space for salvaged goods depends greatly on how well the Goodwill and ReHarvest attendant screens materials for donation. Goodwill for example, has a fairly high staff turnover and the City of Tacoma's experience has been that when attendants empty collection boxes, an abundance of materials ends up in the garbage and no associated fees are collected.

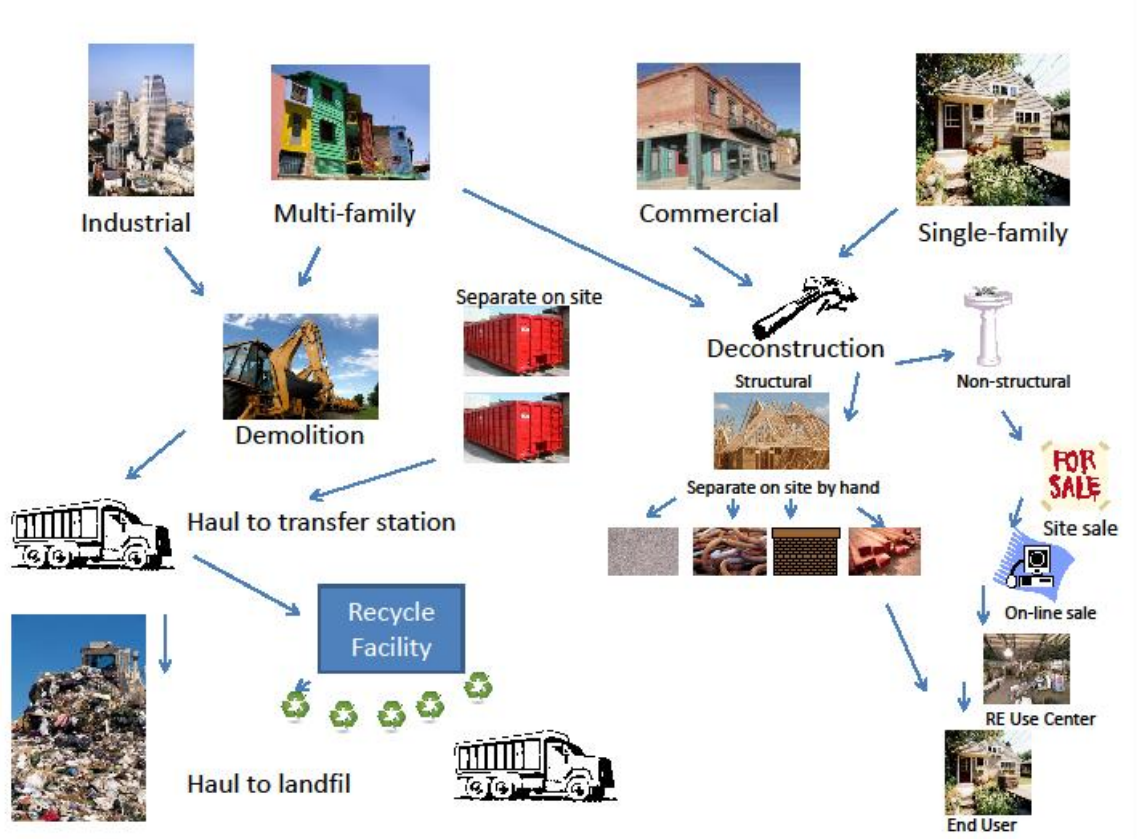
Warehouse space is needed to house salvaged materials, yet affordable space is difficult to find. If a warehouse space is not available in the City of Tacoma, it is vital to direct people with reusable materials to businesses or non-profit organizations able to collect the materials. The Tacoma/Fife tide flats have multiple recycling facilities, empty warehouses, and transportation and port services. Perhaps this area could provide business connections needed for warehouse space.

Nationally, a typical new home weighs about 339,000 pounds, or more than 150 tons. This includes building materials, appliances, and cabinetry. Specifically, this includes 46,000 pounds of lumber, 16,000 pounds of drywall, 13,000 pounds of plywood, 750 pounds of plumbing piping, and 200 pounds of nails (Valley Home Builders Assoication, undated). In order for deconstruction to be successful, these materials need to be covered, stored, and a market for C&D materials needs to be established.

6.2 Public Perception of Used Building Materials in Tacoma's Marketplace

For deconstruction to be more developed and wide-spread, a comprehensive economics chain of production, supply, logistics and consumption of building materials from salvage of demolition waste needs to be established. Demand stems from final users/end markets (developers and contractors sourcing previously used materials as well as landfills) and the intermediaries that service them with such materials (haulers, recycling facilities, and reuse stores). In some cases, recipients pay for materials in order to resell them to ultimate end-users (i.e., recycling facilities), while others charge a fee to the supplier for depositing them (i.e., landfills and tipping stations). The following diagram clarifies a typical flow of materials.

Figure 2. The Market for Construction and Demolition Materials



Downcycling, the recycling of a material into a material of lesser quality or re-use of a product with crippled functionality for alternative purposes, has introduced Tacoma's market to alternatives to using virgin building materials. In 1993, Recovery 1, located in Tacoma, started manufacturing operations to produce wood boiler fuel by extracting wood fiber from Construction Demolition & Land-clearing debris (CDL). Although downcycling does not specifically facilitate deconstruction, it does illustrate CDL waste reduction. Currently, Recovery 1 works with 21 different products (carpet, metal, wood, etc) and between 1993 and 2006 the company processed in excess of 1,070,500 tons (5,352,500 yd3) of co-mingled CDL. Gillis accomplished this while maintaining an overall recycling rate of 98%[9] (Recovery 1 website). Recovery 1 currently does not have warehouse space to store and sell used building material (presentation at Pierce County Coalition for Environmental Health Priorities 9/15/2008).

[9] 67.564% from 1993 through 2009 has been for wood fuel (email from Terry Gillis, 8-17-2009)

The reuse of building materials mitigates the environmental burdens that demolition projects face. Moreover, financial benefits can be generated from the selling of dismantled building materials. In order for this to be successful, the secondary materials market needs to mature and increase awareness of utility of secondary materials in new construction projects (Pun, 2005). The struggles from an influx market can be reduced by the City of Tacoma by establishing a waste diversion plan.

6.3 A Passive Waste Diversion Plan and Shaming

Diversion plans facilitate waste reduction goals, assist in record keeping, and facilitate the recycling and reuse market. Tacoma does not have a waste diversion plan that incorporates demolition, deconstruction, or building permits. On July 15, 2008 the Solid Waste Advisory Committee (SWAC10) met to discuss actions, mechanisms, and affected parties of a waste management plan (SWAC meetings minutes 7/15/2008). Specific actions proposed during the SWAC meeting included: 1) make amendments to RCA 70.95 requiring communities with a population over 10,000 to divert 60% of their waste steam attributed to C&D, by requiring a recycling/reduction program; and 2) develop a model ordinance where applicants at the time of permitting, for construction or demolition of a residential or commercial building, will be required to submit a Debris Management Plan (DMP) and a performance guarantee. As of May 2009, there has been no action with the SWAC proposal.

Tacoma requires all businesses that offer hauling services to register with the City, under Tacoma Municipality Code 12.09.070 Special Permits. As of 2007, approximately 40 haulers companies have registered since the City began enforcing the rule (Champaco, 2007). Tacoma officials acknowledge that some recyclers likely operate without a permit, some recycled goods are unregulated, and any private hauler can negotiate to pick up large loads. "Shaming" occurs when licensed companies combine non-recyclables with recyclables. Shaming is a large concern for Tacoma's waste management operations and must be properly addressed through inspection or audits (pers. com Bill Smith, Senior Environmental Specialist, 4/2/2009). This is a barrier to deconstruction due to the lack of oversight.

Shaming and the lack of auditing recycling and waste containers in lieu of a nonexistent waste diversion plan is a large barrier to well planned deconstruction. SWM tries to divert salvageable goods from new

[10] The SWAC consists of fifteen (15) voting members who represent a balance of interests. SWAC members are citizens, members of public interest groups, professionals from the business community, operators of solid waste collection and recycling companies, and representatives of local governments. SWAC serves in an advisory and technical capacity to the Pierce County Council and Pierce County Solid Waste Division on matters relating to how Pierce County manages solid waste disposal (trash) and recycling services.

construction and remodels by educating through the Enviro House, and provide access to donation facilities, yet the C&D waste stream has not seen a significant reduction.

6.4 Current Redevelopment and/or Land Use Codes

The City of Tacoma does not have building or land use codes that encourage deconstruction and/or discourage demolition. Codes were updated in 2009 and communication with the Office of Sustainability is planned (pers. comm. Debbie Bingham, City of Tacoma 11/17/2008). There is no information posted in the permitting office to educate applicants about deconstruction or its associated benefits. Existing building codes tend to be static and inflexible, thus slow to change along with the construction and demolition industry. As a result, they hinder the incorporation of used building materials into new construction or renovation. Codes also need to be more bioregionally appropriate, considering local climate and other environmental factors (Florida Building Commssion, 2002). Codes need to encourage and allow the use of more reclaimed and remanufactured building materials. This will encourage more contractors to salvage materials for eventual reuse and/or resale, which will also support used building materials supply outlets and companies that remanufacture these items (i.e. wood products into flooring).

Further barriers to the lack of land use codes that encourage deconstruction include the lack of historical data and Tacoma's weak Growth Management Act.

6.4.1 Lack of Historical Building Data

Based on the depreciation and degradation of most of its operational subsystems, the average lifespan of a building is 40-50 years (Shamami, 2001). These buildings won't disappear after 40-50 years, and depending on their land value or health concerns, many buildings remain vacant. Tacoma was established in 1884, and as such, has many buildings that were built decades ago that need major retrofits and/or remodels to preserve their vitality and competitiveness with development. In November 2008, Historic Tacoma recommended that the city council approve and update an expansion of the City's historical resource inventory as part of the scheduled 2009-2010 citywide presentation plan. A preservation consultant was hired in March 2009 and will update neighborhood surveys for Tacoma's preservation plan. With an updated inventory of Tacoma's historical buildings, the City and its citizens can appropriately prepare for the impacts that reconstruction, demolition and/or deconstruction may have on the City. In previous years, establishing a building preservation plan common to both the City and

historical Tacoma has been slow. This has been a barrier to deconstruction in Tacoma because the amount of valuable salvageable items is unknown and a market or need for preservation and repair is not established. ReStore, a privately owned company in Seattle, offers value assessment of a building's salvageable material for a nominal fee of $60. The concept of assessing reusable materials is not discussed in Tacoma's updated inventory preservation plan. This lack of data is a barrier to local deconstruction success.

6.4.2 Lack of Green Building Incentives

Tacoma's land use and building codes continue to act as a significant barrier to deconstruction because they lack green building initiatives. Designing and operating buildings and communities with consideration of their life-cycle impacts can provide major environmental, economic, and social benefits discussed in Section 3. Most, if not all, U.S. cities with any kind of deconstruction process also have some kind of green building program. These programs vary city to city, but all provide a foundation to their climate action plans. The deconstruction process and its outcome parallel green goals in that deconstruction reduces the need for raw materials and encourages sustainable community development.

A brief summary is presented below focusing on each green building program and its relationship with deconstruction. Although many green building practices act synergistically, points in the programs summarized below adhere to waste diversion percentages and types of material used (reused, recycled). Programs generally have sections for site selection, energy efficiency, indoor environmental quality, materials, and water efficiency. Energy and water efficiency tend to be the highest points awarded, however waste management plans tend to be prerequisites or mandated.

Table 2 Green Building Program Comparison in relation to Deconstruction

Name	Location	Program	Compliance	Relation to Deconstruction
NAHB[1]	National	Guidelines	Various professional certification, guideline specific	Points awarded for deconstruction for salvaging material, and for dedicating onsite bins/storage to facilitate sorting.
Build It Green [2]	California	Guidelines	Self-certified	Recycle or recycle requirements, discusses benefits for deconstruction
EarthCraft House[3]	Southeast	Guidelines	Third party inspector approved by Southface	Nothing for new construction, renovation projects obtain few points for appliances, cabinets, millwork, and/or trim.

Built Green Seattle[4]	Seattle, Washington	Guidelines	Self-certified by builder, developer or designer. For 4 stars, need 3rd party verification	Point for reuse building material, reuse sell or give away non code items.
Green Globes (Green Building Initiative) [5]	National	Guidelines	Third party verification that is system is questionnaire-driven	Resources including emphasis on minimal consumption of resources and reuse is only 10% of total program points
Boulder Green Points[6]	Boulder, Colorado	Code	City inspected and self certified	An applicant proposing to demolish more than 50 percent of exterior walls shall demonstrate through a deconstruction plan that at least 65 percent of material by weight from the deconstruction of the existing structure, including concrete and asphalt, will be diverted from the landfill.
LEED [7]	National	Guidelines	Third party verification through the Green Building Certification Institute	Points for waste diversion and use of reused goods in MR c2: C&D Management.
Earth Advantage[8]	Licensed states	Guidelines	Earth Advantage representative	Resource efficiency is goal, but no mandated percentage of reuse or salvage goods is noted.

1 http://www.nahbgreen.org/content/pdf/nahb_guidelines.pdf

2 http://www.builditgreen.org/greenpoint-rated/guidelines

3 http://www.earthcrafthouse.com/resources/builder-guidelines.htm

4http://www.builtgreen.net/checklists.html

5 http://www.thegbi.org/green-globes/

6 http://www.bouldercolorado.gov/files/PDS/green_points/902.pdf

7 http://www.usgbc.org/ShowFile.aspx?DocumentID=3998

8 http://www.earthadvantagehomes.com/index.php

7. Deconstruction Policy

In 2007, the National Association on Industrial and Office Properties (NAIOP) conducted a survey of 53 developers, consisting of 37 architects and 22 local governments, to compare green building programs in different jurisdictions. This survey did not focus on deconstruction, but the findings indicated that many of the programs involved share the same goals that deconstruction has, specifically those related to building and resource reuse, storage and collection of recyclables, and waste diversion. The survey

highlighted a wide range of green building incentives that include, but are not limited to, municipality-priority permit processing, expedited plan reviews, loan funds, direct grants and tax credits. It also enabled NAIOP to conclude that the participants shared similar attitudes with respect to green building incentives. These groups were practical and business-oriented yet optimistic about the probability of achieving sustainability in the built environment, but were generally concerned about the financial feasibility of whatever incentives were proposed. One surveyed developer stated, "The incentives will stimulate enough activity to create the necessary infrastructure to bring the costs down." Another developer noted, "A proactive city that supports sustainability and streamlines the process would really help. Time is money for developers/owners/contractors." In probing what additional development incentives would make a difference to developers, the majority of responses concerned incentive-based policy and included:

Expedited permit processing (13%)
Tax reductions (13%)
Density bonuses (13%)
Expedited plan review (13%)

One survey question asked, "From your knowledge or direct experience, what two cities or counties do you think have the most successful green building incentives in place?" Both responding cities, Chicago (13%) and Portland (9%) will be explored further in the following sections identifying their C&D recycling, reducing and reusing incentives.

Although the NAIOP study analyzed green building incentives, it is important to understand developers, architects, and local government's motives on green building because it may provide insight into how deconstruction, waste diversion plans, and salvaged materials are perceived by such entities. Understanding which stakeholders are involved is crucial to facilitating sustainability efforts, such as deconstruction activities.

Sections 7.1 through 7.4 present deconstruction programs from five different U.S. cities. These programs represent a variety of policy initiatives, and provide examples of how the City of Tacoma can establish a successful deconstruction program. This inventory of ideas describe deconstruction, salvage, or waste diversion initiatives currently in place, followed by a brief synopsis of the initiative and/or incentive development, resulting benefits, and barriers that are yet to be overcome. Table 3 summarizes each city analyzed and information related to their deconstruction policy/program.

Table 3. Table for City Deconstruction Programs: An Inventory

Case Study	Related Barrier for the City of Tacoma	Program	C&D Tipping Fee	Signed U.S Mayor's Climate Protection Agreement	City Specific Green Building program Initiative
Tacoma, WA		No Policy	$50.00 per ton	Yes	No
Seattle, WA	Market perception of time restraints	Expedited Permits	$96.25 per ton	Yes	Yes
Chicago, IL	Lack of warehouse space and knowledge on deconstruction and salvage	Partnership to establish Salvage Store	$20 to $45 per ton[2]	Yes	Yes
San José, CA	Lack of warehouse space and knowledge on deconstruction and salvage	Diversion Deposit	$75 per ton[1]	Yes	No
Portland, OR	Lack of green building incentives	LEED through Feebate	$75 per ton	Yes	Yes
Boulder, CO	Requirements to oversee improper disposal (shaming) and the challenges with not having a city regulated waste diversion plan	Salvage Assessment. Also demolition waste assessment with demolition plan	$32 per ton[3]	Yes	Yes

[1]Cost is obtained from Zanker Road Landfill, which owns and operates three major recycling and composting facilities in the San José area. To convert provided cubic volume C&D weight was averaged from NAHB. Weight of average C&D waste was obtained from http://www.recyclecddebris.com/rCDd/Education/Documents/HandoutCalculatingWaste.pdf
[2]http://www.cdrecycler.com/articles/printer.asp?ID=3440&IssueID=78&Source=back
[3]http://www.epa.gov/osw/conserve/downloads/recy-com/chap02.pdf

The first two cases, Seattle and Chicago, established incentives for known barriers to deconstruction in their Cities. These programs can be easily combined with other programs and smooth a bottle-neck situation that challenges deconstructions success. San José, Portland, and Boulder have programs that are

difficult to borrow specific elements from. Their deconstruction policies are a single aspect of a large, more intricate policy, such as green building policies or policies that detail specific waste reduction percentages. The five cities explored present either composed pieces (sub policy) that can be adopted in their own rights or integrated policy which needs to be adopted in its entirety.

7.1 Decoupling Permits in the City of Seattle

On July 16, 2007, the Seattle City Council unanimously adopted a zero waste strategy (Resolution #30990) to increase recycling and reuse. Zero waste is a philosophy that encourages the redesign of resource life cycles so that all products are reused. Seattle used policies in an effort to reach their goal of recycling 72% of Seattle's waste by 2025. For C&D reduction, reuse, and recycling, Seattle focused mainly on creating a green building team and assessing different projects to evaluate cost effectiveness and waste diversion potential. This pilot found that 1) full deconstruction yields more salvage, 2) time frame is a critical issue, 3) training is key, and 4) the importance of researching recycling facilities.

By conducting case studies, Seattle found that timing is a crucial step in overcoming (one of Tacoma's) barriers to deconstruction. By expediting the processes, Seattle was able to establish a market for deconstruction. This concept sparked discussions between the Seattle Public Utilities (SPU) and the Department of Planning and Development (DPD), and eventually they developed the necessary permit modifications to accomplish Resolution #30990's waste-reduction goals. Incentives for waste-reduction and disincentives for waste creation were also explored. This included internal DPD meetings, where six participants met twelve times, and then an additional ten meetings with SPU. There were 3-4 representatives from both groups at the joint meetings (pers. comm. Sandy Howard, DPD, 3/11/2009).

Seattle has continued to move forward with their efforts toward reducing the C&D waste stream by creating work plans with a contingency to recycle 100% asphalt, brick, and cement, (ABC) from sites, as well as a contingency for a certain recycling percent of the entire project. Their work and progress on adopting new initiatives to have zero waste by 2020 (Resolution 30990) and assessing their major barrier to deconstruction, identifies why Seattle is seen as a leader in waste management policy.

7.1.1 What can be learned from Seattle's Permit Changes

According to the survey conducted by the NAIOP, expedited permit processing was one of the four most desired factors that could make a difference in the green building market. This study shows the importance of having a timely process for green building aspects such as deconstruction, or other waste mitigations, which can shape market perception. Decoupling permits do not require any specific financial

implications; it's primarily just added review time. It is expected that the legislation will impact about fifty projects annually and require about 15 minutes of review time per project (pers. comm. Sandra Mallory, Green Building Program Seattle Dept. of Planning and Development, 2/16/2009). The change to project review requirements can be accommodated by existing City staff within the existing work time allotted for project review. Decoupling permits to ease deconstruction efforts is just one step that SPU and DPD have launched. DPD is working with SPU to develop C&D recycling incentives through regulatory changes. This would establish mandatory recycling levels for projects above a certain threshold, and a "certification program" for C&D processing facilities (City of Seattle, 2009). Decoupling permits have been a successful way to encourage (voluntary) deconstruction, prior to making regulatory changes that may require deconstruction practices. It has provided awareness to deconstruction and salvage prior to waste diversion enforcement on salvageable materials.

7.1.2 Using Seattle's Permitting System to Overcome Tacoma's Time Constraints to and Market Perception of Deconstruction

Building permits, both commercial and residential, are required in the City of Tacoma to erect, modify, remove or repair any structure; this can include anything from new building construction to fences, fireplaces and signs. Once Tacoma's Building & Land Use Services approves a complete set of project plans, a building permit is issued. Although establishing a decoupling process takes time, (as exemplified by Seattle where it took over a year to develop and implement) it can be very effective at releasing the time restraints of deconstruction. Perceived time restraints have a negative effect on the market perception in Tacoma; by establishing a process in the permitting office to easily facilitate deconstruction, this perception will change and the industry trends will move toward reuse of materials. Decoupling the permitting process in Tacoma may be the most cost effective process to contextualize into their current land use code. Decoupling permits would not require complete overhaul of the current permitting process, rather Tacoma could use this incentive devise as educational outreach for options rather then demolition.

Decoupling permits should be included in Tacoma's inventory of deconstruction incentives because it has the potential to create quick, cost effective changes in the amount diverted C&D waste; even though it is too early to tell its actual diverted percentage in Seattle. It is important to note that Seattle did not create an expedited permit process with the sole intent of encouraging deconstruction; Seattle also established resources for green building education, and strict guidelines to follow for waste diversion. Although deconstruction is not specifically mentioned in these policies, they policies will effect Seattle's C&D calculations.

Tacoma's land use services and waste management are both under the public works branch; this is not true of Seattle. For the decoupling process, the City of Seattle had to work with different branches (Public Utilities and Department of Planning and Development) which can slow down communication and other implementation processes. Decoupling the building and teardown permits can be a successful voluntary step for Tacoma's progress in deconstruction policy. Decoupling permits can help Tacoma's overcome the barriers discussed in Section 6 by providing knowledge about deconstruction and salvage which in turn can change Tacoma's market perception of used building material. Creating a permit process that encourages deconstruction ties in successfully with waste diversion plans and green building practices, and also reduces the risk of encountering some of the barrier's that Seattle faced, such as time constraints.

7.2 Partnering with Non-profit Organizations in Chicago, IL

Until recently, Chicago held the record for the highest number of teardowns according to the National Trust for Historic Preservation (Rubenstein, 2007). Because of this, the City of Chicago and State of Illinois promulgated several requirements and programs that encourage building deconstruction and material reuse. These requirements and initiatives were summarized by in a report by the University of Illinois (Weber *et al.* 2009) and include an Environmental Action Agenda and a Climate Action Plan describing diversion goals and waste reduction percentages. These programs include ordinances and building standards that provide education, recommendations for C&D recycling and reuse, and demolition deterrents such as demolition tax to low income housing. Although these building regulations and ordinances are in place, the City of Chicago still faces challenges to deconstruction such as low tipping fees, no physical limits to land filling, a slow permitting process, and similar to the City of Tacoma, a lack of material reuse infrastructure (Hampton, 2008).

In efforts to reduce the challenges caused by not having material reuse infrastructure, the City of Chicago partnered with the non-profit, ReBuilding Exchange. Funding of the Rebuilding Exchange has, thus far, come in the form of a $30,000 grant from the Illinois Department of Commerce and Economic Opportunity Recycling Expansion and Modernization (REM) Program and a $39,000 grant from the US EPA. The Delta Institute, a Chicago-based organization incubates models of sustainable economic development and helped find funds to implement the ReBuilding Exchange. The mission of the ReBuilding Exchange is to divert building materials from the waste stream and make them accessible to the public for reuse, protecting community health, creating jobs and saving resources. The ReBuilding Exchange does this by making used build materials available for purchase at low costs, by providing educational resources and by creating programming that builds community and rebuilds Chicago's neighborhoods.

After three years of obtaining funds and resources, the non-profit ReBuilding Exchange opened its doors in February 2009. The Delta Institute's facility serves as a clearinghouse for salvaged building supplies that will, among others, divert waste from landfills, conserve energy-intensive resources, create jobs for the underemployed and provide affordable materials (Delta Institute website). The Delta Institute is seeking additional funding to incorporate some of the recommendations from the University of Illinois report. It is still too early to note the amount of mitigated C&D wastestream; however, the ReBuilding Exchange met its sales projections and is encouraged by its public support.

7.2.1 What can be learned from Chicago's Partnership

Partnerships take time, work, and patience, but can be very rewarding in facilitating the market of deconstruction. Administrations typically partner because they lack resources such as staff time or funds. Projects such as establishing a reuse facility, take dedicated individuals who is passionate about making a difference in their community. It also takes a great deal of political and community support, publicity and leadership from authority. Having experience with grant writing or establishing financial growth makes a significant difference in the success of any partnership.

7.2.2 Establishing Partnerships in Tacoma to Overcome Lack of Education and Market

Partnerships with reuse stores and other salvage organizations can help create a warehouse space for the reuse market as well as improve public knowledge about deconstruction and salvage. Tacoma has established an agreement with Goodwill Industries and ReHarvest to provide their services at the recycling center; however this remains the only agreement or partnership between the City and another organization with regards to deconstruction endeavors. There are approximately 31 recycling and reclamation facilities for different kinds of C&D materials located in the City of Chicago (Weber *et al,* 2009). This provides many possible organizations for partnerships and/or support. The City of Tacoma could seek partnerships in facets such as partnering with local colleges to conduct case studies, brainstorm innovative project ideas, and hold project competitions. Community supported groups, such as Historical Tacoma, or Government Agencies, such as The Washington State Department of Community, Trade and Economic Development (CTED) are also a possibility. CTED is the lead agency charged with enhancing and promoting sustainable communities and economic vitality in Washington State. Along with colleges' non profits, and governing bodies, a network is possible for deconstruction warehouse partnerships. Partnerships with "big box" retailers have yet to be explored. One Home Depot's retail location, for example, neighbors Tacoma's landfill. The vacant land may be open for development or expansion.

Remodelers or contractors may find unique materials, while also finding consistent, new products in the same vicinity.

Both Seattle and Chicago provide examples of how specific barriers to deconstruction can be reduced. These two cities instill concepts that can be incorporated and molded into unique policies for the City of Tacoma. They can be used together or separately. To add to the inventory of deconstruction policy, Chicago, Boulder, and Portland provide integrated policies that could be used independently. Tacoma for example, would not require a deposit program (San José) and also a feebate program (Portland). These are discussed in turn below.

7.3 Demolition Debris Deposit in San José, CA

Cities in California have been working toward the current 50% waste diversion goal since the California Assembly Bill 939 was adopted in 1989. In 1999, mandate AB 75 added new provisions to the Public Resource Code (PRC) to help all state jurisdictions achieve this goal. This mandated that State agencies, universities, community colleges, and designated state facilities develop integrated waste management plans and divert 50% of their solid waste by January 1, 2004. As part of the legal requirements, large State facilities are required to submit annual reports to the California Integrated Waste Management Board (CIWMB), a board responsible for documenting actual solid waste diversion (CIWMB, 2003).

The City of San José developed a Construction Demolition Debris Deposit (CDDD) in an effort to encourage reuse and recycling of building materials in 2001 (BioCycle 2003); this was also intended to document their facility's solid waste diversions. This policy requires an upfront deposit based on the estimated waste generation for a demolition project. Upon completion of a project, and documentation that supports 50% of the waste generated by the project has been reused for distribution or transferred to an appropriate (certified) recycling facility, the deposit is returned. Within the first six months of the CDDD program, the total deposit value was $1.43M with an average deposit of $815.00. CDDD's rate structure is based on the buildings square footage and is presented in**Error! Reference source not found.**.

Table 4. San José, CA Construction Demolition Debris Deposit Rate Structure

Building Segment	Rate $/Sq. Ft
Residential New Construction	$0.20

Nonresidential New Construction	$0.10
Residential alterations	$1.16
Nonresidential alterations	$0.35
Residential demolition	$0.35
Nonresidential demolition	$0.10
Roof with tear-off	Flat Rate $100

An example of a certified facility in San José is Waste Management's Guadalupe Landfill. The facility is designed to process 200 tons/day of mixed C&D debris. In 2002, the first year of operation, approximately 50,000 tons of C&D materials were processed. In 2003, the diversion rate was 67% with a 25% credit for alternative daily cover[11] (ADC) as allowed for under San José's CDDD program (BioCycle, 2001).

The City of San José provides contractors the option of bringing all materials to city-certified facilities. City-certified facilities are those that have demonstrated that they can meet diversion minimums; relying on city-certified facilities transfers the burden of meeting ordinance requirements from the contractor to the facility. As such, city-certified facilities are more attractive to contractors than other facilities. In an effort to remain competitive, uncertified facilities have no choice but to become certified. The City lists 22 certified facilities on its web site, 14 of which are in the City of San José.

Certifying facilities combines demolition permits with an economic incentive to reuse and recycle demolition debris. It also encourages the development of the local reuse and recycling business sector to provide infrastructure and markets for contractors, without having to directly subsidize them. Construction and demolition debris diversion deposit programs such as San José's (a similar program is in place in San Diego, CA) have proven successful in increasing diversion of construction and demolition debris and have been favorably received by the California Integrated Waste Management Board.

A commissioned study examined inbound C&D waste that was slated for disposal or designated for processing at ten facilities certified under the San Jose CDDD program. The objective of this study was to determine the composition of incoming C&D waste and the prevalence of recoverable materials still

[11] Alternative daily cover (ADC) means cover material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging

being disposed for each waste sector. Results found that 72% of recycled C&D waste could be used for other means, such as salvage purposes (Cascadia Consulting Group, Inc., 2008). This concludes that perhaps enforcing C&D accountability reduces C&D waste; however it does not increase the use of salvage and reuse.

7.3.1 What can be learned from San Jose's Debris Deposit System

Like any strategy, the implementation of a building permit C&D reuse and recycling fee deposits program has its benefits and its drawbacks. The notable benefits of the San Jose Deposit system include:

- Encourages recycling through an economic burden. Provides money to subsidize and encourage markets, recycling, salvage and deconstruction;
- Discourages illegal dumping;
- Addresses source reduction and waste prevention, as well as reuse, salvage, deconstruction and recycling;
- Achieves high diversion with relatively low costs to the City and users.

Several studies have concluded that deposit systems are more cost-effective than other methods of reducing waste disposal, such as traditional forms of regulations, recycling subsidies, or advance disposal fees (ADF) alone. A study by Palmer et al. (1995) concluded that a 10% reduction in waste disposal would cost $45 per ton of waste reduced under a deposit system, compared to $85 per ton under advance disposal fees and $98 per ton under recycling subsidies. However, administrative costs are an important consideration when determining whether or not to create deposit systems and the study acknowledges that the relatively high administrative costs of a deposit system could outweigh potential cost savings. Ackerman et al. (1995) estimate that administrative costs average about 2.3¢ per container more than $300 per ton for steel containers and $1,300 per ton for aluminum cans in states with traditional legislation on beverage container deposit systems. A full assessment of the desirability of deposit-refund systems would compare administrative costs and the costs imposed on consumers with the benefits of reduced disposal costs, energy savings, reduced litter, and other environmental benefits. Deposit-refund systems appear best suited for products whose disposal is difficult to monitor and potentially harmful to the environment. In addition to administrative costs, other drawbacks to developing a deposit system include:

- Requires additional sites or facility monitoring;

- Economic burden is specifically carried by only those that apply for demolition and construction permits;
- Require city council action/approval.

7.3.2 Implementing a Debris Deposit System in Tacoma to Overcome Lack of Warehouse Space and Deconstruction Market

Warehouse space and an established market for deconstruction, both barriers for Tacoma, are focal points in San José's program. By establishing a fiscal initiative, and facility certification, a market for deconstruction was shaped. San José established a market for reuse and recycling services through certification which in turn created warehouse space and established a shared market between public and private entities. San José's deposit system also requires proof of receipt, which helps to reduce shaming.

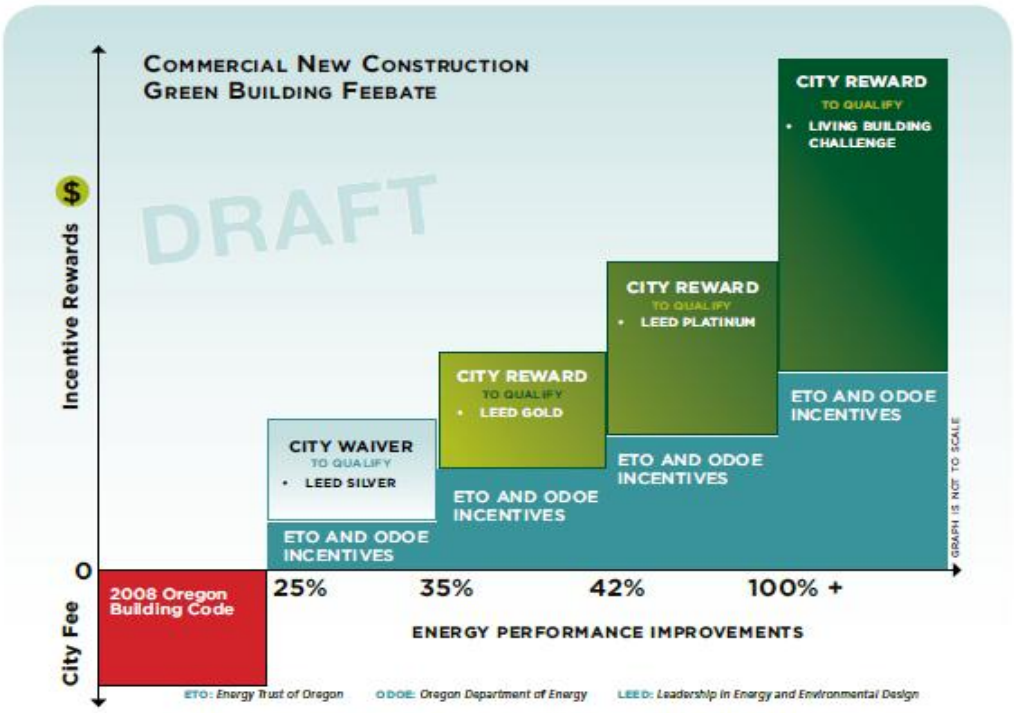
The market has been more successful in the upcycle of goods, rather than salvage or reuse of material, which implies that deposit programs may help waste diversion percentages in general, but not deconstruction or salvage material specifically. In order to encourage residents in the City of Tacoma to use certified facilities, a high deposit fee would be required to make it cost beneficial to pick up their deposit, rather than go to less expensive landfills in Pierce, Mason or Thurston County cities. The challenge is to price tipping fees and waste deposits high enough so that collecting a waste deposit makes more financial sense. However, the construction industry has seen substantial economic decline from the current recession, and it may be a difficult time to require an up-front cost to developers and facility owners. Tacoma must find the middle of the "carrot and stick" dilemma. Tacoma should expand green building codes and establish requirements similar as a C&D deposit program. A deposit system like the one established in San Jose, is likely to provide Tacoma with the necessary financial resources to fund further deconstruction programs.

7.4 Waste Diversion Plans through LEED in Portland, OR

The City of Portland created up front planning which enabled sustainability to be integrated into the construction process from start to finish through their new Bureau of Planning and Sustainability. In January 2009, Portland City Council merged the Bureau of Planning and the Office of Sustainable Development to create the new Bureau of Planning and Sustainability. Proposed for 2010, new commercial and multifamily construction projects 20,000 sf. or larger will use a green building "feebate"—a market-based instrument that combines a fee for conventional construction, a waiver option for moderate green building improvements and rewards for high performance green building projects.

Buildings that meet Oregon's state building code would be assessed a fee by the city of up to $3.46/sf. This fee would be waived for buildings that achieve LEED Silver certification from the U.S. Green Building Council. Those that achieve LEED Gold, LEED Platinum, or meet the Living Building Challenge, would receive rebates of $1.73-17.30/sf, depending on certification level. Figure 3 describes Portland's incentive policy for green building and shows the tiered feebate options: reward, waiver, or fee.

Figure 3. Portland's Proposed Green Building (Draft) FeeBate Policy



With financial incentives to pursue green building, Portland anticipates a double in the number of homes that achieve Earth Advantage (silver) or LEED for Homes certification. In Portland, C&D waste accounts for approximately 20% of the wastestream. According to Metro, almost 60% of that amount could be reused or recycled. Utilizing deconstruction can earn points towards LEED certification and can help builders meet the City of Portland's jobsite recycling requirement of diverting 75% of C&D waste for jobs with a permit value of $50,000 or more (this is already required under Portland City Code, Chapter 17.102). It will also prepare applicants for Portland's Feebate Program that will be rolling out in fall 2009. These policies are important to deconstruction activity because with Portland's Green Development Resource Center & Hotline, approximately 98% of projects pursue the LEED credits Material and Resource 1 and 2.

Portland follows the state of Oregon in its efforts to increase salvage and reusable building material by proposing a green building strategy that recognizes deconstruction and salvage material. The state has projected initial incentives of about $2.3 million between 2010 and 2025 to result in emission reductions of 16,000 MTCO2E in 2025 (US EPA, 2009). It is not certain if this figure accounts for establishing the feebate system.

7.4.1 Establishing "Feebates" in Tacoma to Overcome Market Barriers and Encourage Green Building

Establishing an influential green building program generates a market need for deconstruction through community awareness and policy incentives. Portland's high diversion rate stirs the market for salvage and reuse. Unlike Boulder's Green Points program (discussed below), green building guidelines such as LEED certification are not required for non government buildings, but a "financial stick" is used to push green building practices. Portland established mandates on the amount of C&D waste generated on jobsites, and a zero waste policy for concrete/asphalt, land clearing debris, corrugated cardboard, metals, and wood. These concepts create a stringent waste diversion plan that should increase deconstruction and purchasing of salvage material.

It is important to understand the connectivity of green buildings and deconstruction. Tacoma's Green Task Force used language from LEED to facilitate this importance. In April 2005, Washington became the first state in the nation to adopt legislation requiring that all new state construction meet LEED standards (May and Koski, 2007). This standard establishes a market for qualified industry leaders in the field of sustainable development. Portland has created a very innovative enforcement mechanism to enforce its stringent green building regulations. The city looked at the market over a long period of time, and felt that the freebate system will provide economic stability, develop green collar jobs, and address climate change while offering a financial reward to commercial developers. This policy can work for the City of Tacoma, but it must be approached whole-hardily, adopting important tool such as education, stakeholder meetings, and user friendly waste diversion plans. Portland used LEED standards and the Living Building Challenge as its highest rated green building. The City of Boulder, adopted its own requirements of green building as discussed below.

7.5 Green Code Requirements in Boulder, Colorado

In order to meet Boulder's Climate Action Plan goals, residential builders must fulfill two requirements: construction waste recycling and demolition management. An applicant for a building permit for a new

residential building or an addition to an existing residence must demonstrate that a minimum of 50% of construction waste has been recycled. Recycling all clean wood, cardboard and metal will count for 50% waste diversion. Applicants are required to submit a Deconstruction Plan and Construction Waste Recycling Form with the Green Building and Green Points (GBGP) building permit applications. The Green Points program mission is to protect the public health, safety, and welfare by regulating residential construction with the intent to conserve energy, water, and other natural resources, while preserving the health of the environment through optional and mandatory requirements related to design, construction, operations, recycling, and deconstruction. Setting mandatory green building requirements ensures that construction waste and deconstruction materials are recycled, reused, or otherwise diverted from landfills. It also ensures that dwellings are constructed in an efficient manner.

An applicant proposing to demolish more than 50% of exterior walls must demonstrate that at least 65% of materials have been diverted from a landfill. Materials are quantified by weight and can include concrete and asphalt (pers. comm. Elizabeth Vasatka 8/24/2009). As with the construction recycling requirements, the applicant will need to submit a Deconstruction Plan and Construction Waste Recycling Form and verify through a completed Construction Waste Recycling Tracking Spreadsheet. Most of Boulder's Green Points codes are more stringent then LEED requirements. Salvage and reuse points/credits remain the same, however, all applications must still meet the mandatory requirements for Demolition Waste Management in Boulder's Green Points program.

The City of Boulder's Green Points program is mandatory for anyone who applies for a building permit. Other programs, such as the City of Austin's "Take the Green Challenge" are voluntary. In Austin, program participants can earn up to five stars, reflecting the number of points earned for sustainable practices in energy, water use, material and health- and community-enhancing features. Builders can earn points for reusing materials including concrete, cabinets, doors, interior trim, and flooring. Because "Take the Green Challenge" is voluntary, participation is considered a valuable marketing tool (Manual, 2003), yet lacks the amount of participation as a mandatory program like Boulders'. Elizabeth Vasatka, from the Office of Environmental Affairs noted that "Boulder has the strongest decon program with the most teeth" (pers. comm. 8/24/2009).

7.5.1 What can be learned from Boulder's Green Code Requirements

The City of Boulder faces two challenges to deconstruction: 1) providing ample time to generate the necessary infrastructure and 2) stakeholder involvement to establish a mechanism by which waste is tracked. An additional challenge is the time it takes to construct a building; this generates a lag in

assessing the program's successes and finding measurements to track success and areas that need work. Some projects take 4-5 years, and it is difficult to be transparent and accountable with government resources on a project of this length. The number one priority for Boulder's Green Points program was to have infrastructure in place to create the market that supports regulations. The City also recognized the best approach to quantify waste calculations, and then tried to reduce the "low hanging fruit". The low hanging fruit was first to reduce 50% cardboard, wood, and metal waste from new construction (the majority of waste in Boulder). Even the low hanging fruit, however is affected by the market, which influences waste thresholds for the green points programs.

The thresholds that need to be met are very difficult and can get expensive. Minor challenges come when material is not sellable. Older toilets and windows do not meet energy and water efficiency codes are examples of difficult items to re-sell. In some situations, recycling porcelain is more profitable than others. Knowing what material does not sell in Boulder's contracted ReUse store shows the importance of knowing what goes into the waste stream, the age of houses, when buildings are anticipated to come down, marketability of material and purchasers of the products. Tacoma faces these data gaps, as discussed in Section 6.4.1.

Boulder uses educational resources and contracts with a non-profit business to do site inspections. They average about thirty-seven visits a year (Elizabeth Vasatka pers. comm. 8/24/2009). Preliminary meetings are held to establish what can and cannot be reused or recycled and provide the contractor with the proper paperwork and forms. These inspections establish a much higher learning curve and also reduce the market perception that deconstruction is too time consuming, difficult, or not cost effective. This perception is a challenge that Tacoma faces.

7.5.2 Establishing Green Codes in Tacoma to Overcome the Lack of Green Building

The City of Boulder has been the leader in deconstruction policy and has provided concepts that are instrumental in breaking down some of the barriers that Tacoma faces. Boulder has a well established growth boundary, a successful partnership with the permitting office, and a community that supports green building. They have established infrastructure, educational resources, and regularly analyze their waste stream. These actions reduce their waste stream, generate a market for reuse, and establish steps to combat their climate action plan. Boulder's green points program re-enforces the importance of having strong communication within the City. Although green building policies are not focused specifically on deconstruction, this inventory of deconstruction policy shows where cities establish concepts of green building policy, deconstruction is more successful. Although Boulder still presents challenges to increase

its deconstruction and salvage retail, the City is an example of how a program can apply sustainability principals throughout its policy process.

8. Recommendations for the City of Tacoma

The optimal solution for the environment is to salvage all materials; however, this is not the optimal economic solution for the majority of infant deconstruction programs. Determining the optimal economic solution for Tacoma depends on the economics of the region, of the people in the region, and of area businesses. Without a legal or economic push, the effort to reduce, reuse and recycle is often, unfortunately, ignored. The construction industry, comprised mostly of midsized construction firms, operates under a tight profit margin-usually around 5% (Kibert and Languell, 2000). As in most industries, construction and demolition companies are not willing to jeopardize this profit margin by implementing reuse programs or expanding their demolition practices to deconstruct if the company is not afforded an immediate and significant profit. Most businesses feel it is simply not worth the financial risk of often negative monetary payoff to be environmentally friendly.

In communities throughout the United States, required recycling and incentive strategies for the commercial and construction and demolition debris waste streams have been successfully implemented. Key findings of the programs profiled in this report include critical elements that established their sucess. By reviewing an inventory of possible program elements, contextual recommendations to barriers facing Tacoma are presented below in the order discussed above.

8.1 Lack of Warehouse Space

Infrastructure development grant programs are an effective means to increase processing capacity and waste reduction efforts. The City of Chicago indicated that grant assistance was one of the most cost effective strategies when establishing waste diversion programs. Tacoma may benefit from exploring the Community Regeneration Act, which would create a new, competitive program within the U.S. Department of Housing and Community Development (HUD) targeted towards cities and metropolitan areas that are experiencing large-scale property vacancy and abandonment due to long-term employment and population losses. This Act would encourage innovation, experimentation, and environmentally sustainable practices through collaborative efforts to reuse land bank properties in ways that will provide long-term benefits to the public, whether it is through the creation of green infrastructure, economic development, or other strategies (HR 932 IH). The Act also says that both the “deconstruction and demolition of vacant and abandoned properties” and the “demolition and removal of public infrastructure” can be funded through the Act.

8.2 Educate Stakeholders

Education and technical assistance are key factors to the implementation of mandatory recycling and reuse programs. Almost every deconstruction program manager interviewed for this report stressed education as the key to their program's success. It is recommended that all employees in the public works department be educated about deconstruction, and the benefits it can generate. Education may also play a significant role removing lead and asbestos from Tacoma's landfill.

Using a cooperative approach to deconstruction can build program support and influence participation. Program managers emphasized the importance of working with businesses, haulers and other stakeholder groups to develop the most attractive program. All cities analyzed conducted intensive surveys, held meetings and gave presentations. It is recommended that Tacoma start this cooperative approach through its Office of Sustainability.

8.3 Enforce a Waste Diversion Plan

Models for deconstruction site management using material-flow modeling plus project scheduling can greatly benefit the salvage market and construction and demolition industry. This, along with understanding what resources are available to the City, can make a significant difference. Data adopted from the preservation plan can provide historical dates which could initiate proactive planning. Accurate record keeping is recommended in Tacoma's land use codes and waste management facilities.

8.4 Strengthen Green Building Policy

Deconstruction needs to become more permanently established as an alternative to demolition, and should also be looked at as a basic principle of green building and sustainable development. Tacoma should employ green building codes, emphasis designing for disassembly and provide flexible building code for use of salvage goods. It is also important to educate on sustainable resource management.

9. Conclusion

Issues of declining landfill space, loss of embodied energy in existing building materials, pollution, and various forms of ecological devastation are problems on both a national and regional level. For this reason, it is imperative that we begin to seek creative solutions to our ongoing environmental problems. Deconstruction can fill a vital role in resource conservation, while also serving as a model for progressive thinking with regards to sustainable development and growth.

The increasing amount of C&D waste generated in the world is not a problem that can be resolved entirely through political will, government mandates or private sector innovation. Like many of the issues facing our region and country today, to make deconstruction successful, it will take brainpower and cooperation from the private and the public sectors, including everyone from elected officials to subcontractors on the jobsite. It will take the voice of each and every stakeholder if strides are to be made in reducing waste, or better yet, in preventing it in the first place.

The recommendations and case studies analyzed in this report are made with the intent to generate discussion on the feasibility of deconstruction within the City of Tacoma and provide an inventory of ideas and policy concepts for the City of Tacoma's Office of Sustainability.

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