Feasibility of Recycling Timber from Military Industrial Buildings

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Abstract

This paper discusses an alternative to the demolition and landfilling of conventional timber frame buildings-the dismantlement and recycling of lumber and timber. A case study is presented in which two large buildings at the Twin Cities Army Ammunition Plant were successfully dismantled and a substantial volume of the timber and lumber recycled. This case study illustrates several aspects of the recycling process: factors that influence the decision to recycle, regulatory and contractual challenges, labor and safety issues, economic factors that affect the emerging market for recycled timber and lumber, short- and long-term advantages and disadvantages of dismantlement as opposed to conventional demolition, and recommendations for making the recycling of timber and lumber elements of excess buildings a feasible disposal option.

Introduction

A significant number of U.S. military industrial facilities are of timber frame construction. Because many of these facilities were built during the World War II era, when steel and masonry building materials were being redirected to other parts of the war effort, timber was the common choice for the construction of industrial facilities. With the end of the Cold War era in the early 1990s, many of these facilities were classified as surplus to the nation's defense requirements.

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Without mobilization missions to justify their continued maintenance many of these buildings have been standing idle, awaiting disposal. These buildings are estimated to contain hundreds of millions of board feet of old growth timber and lumber, as well as a myriad of other components; some of these components are valuable and/or highly regulated with regard to disposal.

The current situation in the military is contrary to the past trend of adding buildings to the industrial inventory and continuing to use existing buildings. In the past, any disposal of buildings was incidental to other ongoing operations and as such was often handled on an individual basis, both administratively and with regard to disposal practices. The typical disposal practice for such facilities has been demolition, with the debris placed in a landfill.

The disposal of military industrial facilities has the potential to increase dramatically. It is timely to review disposal practices used for these assets in order to minimize costs and the potential liability associated with various practices.

This paper discusses the dismantlement of timber frame buildings and the recycling of the timber and lumber content as an alternative to conventional demolition and landfilling. A case study is presented in which two large buildings, representing more than 900,000 ft.^{2} (83,610 m^2) of manufacturing space at the Twin Cities Army Ammunition Plant (TCAAP), were successfully dismantled and a substantial volume of the timber and lumber recycled. This case study illus-

trates several aspects of the recycling process: factors that influence the decision to recycle, regulatory and contractual challenges, labor and safety issues, economic factors that affect the emerging market for recycled timber and lumber, short- and long-term advantages and disadvantages of dismantlement as opposed to conventional demolition, and recommendations for making the recycling of timber and lumber elements of excess buildings a feasible disposal option.

The decision to recycle

The decision to dismantle buildings 501 and 503 at the TCAAP was not automatic or unanimous. In the early 1990s, this decision eventually came be regarded as the disposal option consistent with various missions and directives. The primary event that precipitated the dismantlement of these manufacturing buildings was the end of the Cold War era. Subsequently, in fiscal year 1992, the decision was made to terminate TCAAP's small caliber (5.56- and 7.62-mm) ammunition manufacturing mission and the artillery metal parts (105- and 155-mm) mission. While there were then and still are other Army missions on the TCAAP Installation, the majority of the buildings had been dedicated to manufacturing and support of the terminated missions. This is significant in that it is a violation of federal procurement law and military regulations to spend federal tax dollars to maintain facilities that are surplus to the military's needs.

With no mission to justify the continued upkeep of many of the Installation's buildings, both heating and maintenance of excess buildings were suspended. While this strategy was acceptable in the short term, it was not acceptable for the indefinite future. A phasedown plan was developed to address the long-term risk of no maintenance while the Army determined its future plans for the Installation. This phasedown plan took the shape of more than 70 projects that addressed various aspects of the manufacturing buildings and machinery and the supporting infrastructure with the intention of proactively eliminating or minimizing the potential long-term risk associated with little or no maintenance or surveillance.

In a process known locally as "killing the building," equipment, personal property, and components that could deteriorate and release hazardous or otherwise regulated substances were removed from the buildings. All utilities were positively disconnected. Finally, all exterior openings were secured and signs were posted in keeping with fire regulations. The utility infrastructure of the Installation was likewise properly abandoned if inactive, and in the case of the electric and natural gas distribution systems, sold to a local public utility company.

For most Installation buildings, this was an acceptable short-term endpoint. The large timber-frame buildings posed an exception. Containing well over a million board feet of wood materials each, these buildings represented a substantial fire hazard to active Installation facilities as well as to the neighboring community. Therefore, a choice had to be made between maintaining a multi-zone fire sprinkler system for each building or disposing of the buildings. The cost to maintain the sprinklers represented several thousand dollars per year per building indefinitely. A decision was made to remove the buildings and the associated fire hazard.

Once this decision was made, discussion followed on how disposal was to be accomplished. Conventional disposal would have resulted in demolishing the buildings and disposing of the debris in a demolition landfill. The question then arose as to the feasibility of salvaging the timber and lumber. This possibility was met with skepticism because of lack of experience and consequent lack of knowledge about whether 1) any contractors were available who actually salvaged timber and lumber 2) there was a market for nonvirgin wood materials; and 3) the additional effort on the part of the Army as owner would be justified.

Research on the feasibility of salvaging the timber and lumber was finally decided to be worthwhile for the following reasons. First, minimizing landfill disposal was consistent with the Army's waste minimization goals. Second, the Installation was already a potentially responsible party at several landfills and disposal site clean-up operations in the area. The financial responsibility for the associated remediation efforts at these landfills and disposal sites underscored the fact that although the disposal methods had been legal, there is a long-term risk of future liability for disposal practices that simply stem discarded materials. Third, we speculated that if these materials had value, they might subsidize the overall disposal costs of the buildings, thereby lowering finding requirements.

The TCAAP contacted several wood-related organizations, including the Forest Products Laboratory of the USDA Forest Service, timber salvage companies, and timber framing contractors. As a result of discussions with these organizations, salvaging timber from the buildings appeared to be feasible. Although opinions about timber recycling were more often quantitative than qualitative, the following conclusions were reached prior to beginning timber salvage:

1. At the very least, the large timber elements were recyclable. It was unclear if there would be a ready market for the smaller timbers or the dimension lumber. Quotations on purchase price ranged from $50 to $200 per thousand board feet (MBF) for the standing timber members.
2. While there were some outlets for the large timbers through brokers, the kinds of markets were speculative to a great extent. The fact that the materials were used seemed to pose an obstacle since they would not carry a grade stamp to satisfy a building inspector for subsequent uses.
3. Those in the timber salvage business apparently were not particularly oriented to peforming other kinds of disposal activities, especially those involving regulated wastes. Interestingly, metal salvage contractors and timber salvage contractors were apparently not particularly interested in the other material.

Building and disposal data

The characteristics of the buildings dismantled at the TCAAP and data generated by the dismantlement process are listed in Table 1. The range of nominal timber dimensions included 2×8 to 2×14; 3×10 to 3×14; 4×10; 6×12 to 6×18; 8×14 to 8×18; 10×18. The estimated value of the recycled timber per board foot was as follows:

- Received by owner for timber in place: $0.05 to $0.20.
- Received by dismantler-smaller dimensions: $0.40 to $0.60.
- Received by dismantlers/brokers-larger dimensions: $2.00 to $3.00.

Note that there does not always appear to be a direct correlation between some values, for the following reasons:

Table 1.—Characteristics of dismantled TCAAP buildings.

Characteristic	Building 501	Building 503
Floor space	377,000 ft.^{2}	548,000 ft.^{2}
Timber	1,250 MBF	1,875 MBF
Wood recycled	750 MBF	1,500 MBF
Transporation & tipping fees avoided	$35,000	$70,000
Future liability avoided	--	--
Estimated cost to demolish and landfill	$300,000	$440,000
Cost to dismantle	$50,000[a]	$283,000[b]

[a] Roofing disposal not part of dismantlement contract.

[b] Roofing disposal part of dismantlement contract.

- Each building had parts of a masonry-type construction, which result in a disposal cost to the owner.
- Disposal of building 503 included a built-up root that of building 501 did not.
- Building 501 was dismantled at higher labor rates than was building 503.
- Application of materials from building 501 into new timber framing and millwork projects created a demand for the material in building 503. As a result, the contractor recovered a greater potion of building 503's timber elements.

Regulatory challenges

Buildings 501 and 503 were used for manufacturing, and contained various building elements, equipment components, and supplies that are currently regulated in regard to disposal. The following materials were encountered on this project:

- asbestos
- polychlorinated biphenols (PCBs)
- mercury-containing instruments and controls
- mercury/cadmium fluorescent light tubes
- treated timber creosote and pentachlorophenol (PCP)
- lead-based paint
- assorted lubricants, hydraulic oils, and quench oils
- explosives: powder, primer tracer, and incendiaries
- partial containers of paints, solvents, and preservatives

Because of the diversity of materials, a substantial and continuous effort went into evaluation and proper disposal as the materials were encountered during the decommissioning and disposal of the facilities.

Contractual issues

All activities undertaken from the time the buildings were production-ready to the time they were reduced to floor slabs on the prairie would have had to have been performed whether the buildings had been dismantled or demolished. The primary difference was that the various steps were handled through a series of contracts, each with a contractor who dealt with separate aspects of the disposal. This allowed the owner better control of the disposal process and to a great extent lifted the burden from specialty contractors. Since dismantling left the buildings devoid of anything but timber and a built-up roof, the contractual procedure gave the TCAAP an opportunity to determine if dismantling and subsequent timber recovery would lower disposal costs. For each building, competition for a disposal contract was open, with no

recycling requirement. The low bidder was chosen, one who could complete the work on time and within budget.

Two categories of contractual issues arose during this project:

1. To what extent should general, all-inclusive disposal contracts be used?
2. What aspects of a building disposal contract are important if dismantlement and recycling of the building are desired?

General versus multiple contracts for disposal

The disposal of buildings 501 and 503 was accomplished through a series of contracts, rather than one. This arrangement is similar to what construction managers refer to as "multiple prime contracts." Although the Army and its operating contractor had to prepare and manage more contracts, this was the most effective way to accomplish the project for the following reasons:

1. The disposal of personal property (production equipment) is a separate action from the disposal of real property.
2. Directly contracting with various types of contractors provided the Army with more effective and expeditious control of the overall disposal effort; they could work directly with the contractors rather through a general contractor. Since there were some instances where change in scope was probable, multiple mark-ups could be avoided if the scope were expanded.
3. It was prudent to contract directly with abatement and hazardous waste contractors. In this situation more than in any other disposal activities, it was important to have a direct relationship with these contractors to ensure compliance with the scope of work as well as better ability to verify the final disposal point of regulated materials.
4. Competition was increased by dividing the overall disposal project into smaller components by specialty or industry. Feedback from bidders indicated that it was better to avoid a contractual chain of custody for hazardous waste, which would result from subcontracting that work. Also, we attempted to frame the work by size and nature so that contracts were large enough to be of interest to bidders, but not so large or outside their primary kind of work as to create bonding or insurance problems that would inhibit bidding.

Dismantlement issues

Several contractual issues affect the feasibility of building dismantlement and subsequent recycling of the materials:

1. The contracts for the disposal of buildings 501 and 503 were just that-contracts for disposal. Recycling was not mandated because a) it was unclear what types of or how much material could be marketed for reuse; and b) under the circumstances, there was apparently no meaningful way to enforce such a requirement. The buildings were cleared of production equipment and hazardous materials prior to setting the disposal contract, making it feasible to dispose of the empty buildings either by conventional demolition or dismantlement. In a competitive bidding situation, the successful low bidder chose to dismantle significant portions of each building.
2. To make dismantlement a viable option, the contract must contain a sufficient performance period. A good rule of thumb is to allow twice the time for dismantlement as for demolition. Dismantlement is more labor-intensive than is demolition, which tends to be more machine-intensive.
3. Some contract bid forms have a subtotal line for a credit for the salvage value of building materials. The bid total is then the total of disposal items on the bid sheet less the salvage credit. It was prudent to require bonding and insurance reflecting the total price of the disposal effort, not including the salvage credit. In a default or other situation potentially involving the contractor's surety or insurance, the cost of replacing the building disposal performance should not include the salvage credit. Depending on a contractor's outlets for various materials, what is feasible to salvage may change with the contractor. This is a function of the fact that markets for some used building materials are in the process of development.
4. Specifically regarding federal and federally funded projects, the contract documents should state whether the project is a "Davis-Bacon" project. The Davis-Bacon Act is a federal labor law that when applicable to a contract significantly affects the cost of labor on that contract. Since dismantlement as a disposal option is labor-intensive, it is crucial to make a correct determination as to whether Davis-Bacon applies to a particular project. A more complete discussion of the Davis-Bacon Act is found in the next section.

Safety and labor issues

Safety

Generally speaking, dismantlement is labor-intensive. The nature of dismantlement is to separate and usually recover building materials in a condition in which they can be reused for the same or similar purpose. This process usually involves "deconstucting," that is, manually disassembling parts of the building.

Demolition, on the other hand, is an equipment-intensive operation, with a large percentage of the crew physically separated from the material being handled. Although materials may be separated during demolition (usually metals, sometimes concrete and masonry), this is usually done mechanically. Typically, it is not critical that the building elements be preserved since the recovery is for the material content. Even though dismantlement is similar to demolition in the respect that both are disposal methods, dismantlement is more like construction relative to the number of persons that maybe on site, where they are likely to be located, and the activities in which they are engaged.

As such, it is imperative that for dismantlement to have a net benefit to a building owner, emphasis must be given to safety-not only in the contract document, but through active and regular oversight and enforcement in the field. Issues that recur on dismantlement projects include the following:

1. ***Awareness.*** People must be aware of what kind of activities are happening, on all levels.
2. ***Fire.*** The danger of fire should be emphasized at regular "tool box" safety meetings. Fire is a very real hazard on dismantlement sites, primarily as the result of the use of cutting torches. Wood materials are typically exmemely dry and will ignite readily. A requirement that a fire extinguisher be kept with each cutting torch is extremely useful; this practice is not as common as it should be. An enforced no smoking policy, except in designated areas provided with "butt cans," will help prevent what is probably the second greatest source of fire. Finally, there should be provision in the contract that all fires be reported to the fire department and the owner, regardless of whether the contractor thinks that the fire has been extinguished. Besides the potential destruction of valuable materials, fire poses a significant danger to people on the site. When a building is being dismantled, utilities are eventually cut off. These include telephone, electricity, and water—all necessary for fire detection, alarm, and sprinkler systems. Especially in multi-level buildings, the prevention of fire is critical to the safety of workers.
3. ***Change from "inside" to "outside" work.*** *As* dismantlement progresses, inside work becomes outside work and potentially can become aerial work. Proper barricading, personal safety equipment, and lifting equipment pursuant to Occupational Health and Safety Administration (OSHA) and other relevant standards must be followed as applicable.
4. ***Dismantlement plan.*** A plan should precede dismantlement. This plan may be relatively simple or quite detailed, depending on whether the original construction was complex or not otherwise obvious. In some cases where buildings are small and simple in design, the dismantlement plan may be approved by in-house personnel of average technical competence. In more complex cases, it is worthwhile to have the plan developed or reviewed by a qualified structural engineer or architect. The point of this effort is to avoid collapse of the building during dismantlement. The other effort necessary to avoid collapse is to enforce the dismantlement plan.
5. ***Airborne dust.*** This maybe a significant hazard or at least an irritant to workers on dismantlement projects. Precautions need to be taken if roof decking and joists are being recovered. Since older built-up roofing may contain asbestos and/or coal tar, it is prudent to sample roofing materials prior to building disposal to determine the proper method of disposal and methods or items of personal protection equipment needed to ensure worker safety. Besides protecting workers, these steps also create a record of positive steps taken to determine what constituents were contained in the roofing materials and what action was taken in light of that knowledge. Such actions are prudent given the current levels of litigation, particularly in relationship to asbestos exposure.
6. ***Housekeeping.*** Housekeeping is a very basic safety issue. Besides directly affecting the hazards described here, good housekeeping minimizes trip and puncture hazards. It also helps prevent loose debris crossing an opening in a floor to give the appearance of a solid floor. Walking across such an area can result in a serious fail.

Labor

As mentioned earlier, federal and federally funded construction projects must comply with the requirements of the Davis-Bacon Act (40 USC 276a, *et seq.).* This federal labor law requires the payment of "pre-

vailing" wages on construction-type work, including new construction, alterations, and repair of buildings and sites of new work. The U.S. Department of Labor issues wage determinations for various job classifications in a given geographical area considered for prevailing wages. In many areas, this is determined to be union wages based on union classifications.

Typically, federal construction-type contracts fall within the purview of the Davis-Bacon Act. Therefore, there is a tendency to assume that all contracts of this nature need to be certified as Davis-Bacon projects. In performing a Davis-Bacon review for applicability, we reviewed the federal regulations on labor and procurement. The Code of Federal Regulations (29 CFR 3) generally discusses labor regulations with regard to contractors and subcontractors on federally financed public works projects. More germane to this discussion is the Federal Acquisition Regulation (FAR) in part 22, *Application of Labor Laws to Government Acquisition. In subpart* 22.402, *Applicability,* paragraph (a)(1)(ii), the regulation includes dismantling, demolition, or removal of improvements where those improvements are part of a construction contract or further construction is anticipated under a subsequent contract pursuant to Subpart 37.3. Part 37 of the FAR, *Servcie Contracting,* includes subpart 37.3, *Dismantling, Demolition, or Removal of Improvments.* In paragraph 37.301 on labor standards, the regulation indicates that these activities could fall under either the Davis-Bacon Act or the Service Contract Act (41 USC 351, *et seq.).* It further indicates that the Service Contracts Act applies if no further Federal construction or improvement is planned. The significance is that the Service Contracts Act requires the payment of a minimum wage in contrast to the Davis-Bacon prevailing wage. This makes labor less expensive in this situation.

Thus, where there is no foreseeable follow-up on federal construction occurring on a site, the disposal contract does not have to be certified as a Davis-Bacon project. Since dismantlement is more labor-intensive than demolition, the feasibility of recovering significant amounts of materials through dismantlement is directly related to labor costs. Again, this issue applies to the federal arena. This issue may not be pertinent to all situations, but some may require the use of a prevailing wage structure to evaluate dismantlement. In instances where the exception cited above can be applied, the feasibility of recovering more material increases dramatically. It is definitely worth exploring the issue of use of prevailing wages where applicable.

Feasibility of recycling timber and lumber

For the purpose of this report, feasibility fails into two categories: material recovery and marketability.

Material recovery

The feasibility of recovering timber and lumber from buildings is dependent on both physical and economic factors, which include the following:

- condition, dimensions, and species of wood
- type and number of fasteners per element
- exposure or protection of elements
- cost of labor
- performance period allowed for building disposal
- building height and site configuration
- time allowed to store recovered materials on site

Marketability

Although the markets for some recyclable materials are well established, this has not been the case for timber and lumber recovered from building disposal projects. For the most part, traditional markets have been local in nature and speculative at best. The use of recovered timber and lumber has often not approached its potentiality. Typically, recovered timber and lumber have been used for compost, livestock pens, concrete forms, and dunnage. However, recent developments have resulted in an emerging market for recycled wood elements. Factors that favor an increase in demand for nonvirgin timber and lumber include:

- restrictions on harvesting high-quality, large-diameter old-growth timber, thereby restricting its availability at any price;
- general trend of increased prices for foest products;
- demand for high-quality large timber for exposed timber frame construction;
- demand for species-specific mill work for use in new log home construction and interior remodeling of older buildings where consistency with period building materials is desired;
- foreign demand for North American species that represent "exotic" species in those markets;
- increased familiarity of buyers, designers, and builders with nonvirgin timber and lumber.

Factors that restrict the demand for nonvirgin timber and lumber include:

- lack of grading standards and design rules specifically for nonvirgin wood materials; application of virgin material standards and rules may have the effect of downgrading nonvirgin materials;
- at the job site, lack of a specific grade stamp for nonvirgin wood elements, which designers and inspectors rely on for acceptance; unless a timber

grader is specifically hired to visually inspect material on a particular job, the material is often rejected for use;

- in general, lack of consistent supplies and markets for nonvirgin timber and lumber
- lack of awareness by owners and their disposal contractors regarding the potential value of nonvirgin timber and lumber, with the result that no attempt is made to recover them.

Dismantlement as an alternative to demolition

All disposal alternatives have their advantages and disadvantages. Dismantlement is no exception. The decision to use dismantlement or conventional demolition as a disposal option will depend on the relative weights assigned to the various factors considered here.

Advantages

- Dismantling and subsequent reutilization of building elements result in avoidance of some landfilling costs, primarily transportation and tipping fees.
- Reduced use of landfills should result in reduced future liability, should a landfill fail and remediation costs be assigned to former landfill contributors.
- There is a demand for large old-growth timber. Properly recovered timber from older buildings is gaining acceptance to meet this demand.
- In addition to reducing disposal costs by not requiring some disposal fees, in many instances recovery of materials will generate a credit or otherwise subsidize the overall building disposal costs.

Disadvantages

- Building disposal may be more management-intensive for the building owner if multiple contracts are let for various types of abatement and disposal, in contrast to one overall disposal contract.
- Dismantlement takes longer than demolition. An owner must plan ahead and allow approximately twice as long for dismantlement as for demolition.
- Dismantlement is more labor-intensive than is demolition, which tends to be machine-intensive. Emphasis on site safety and coordination tend to increase in direct proportion to the number of workers on the same site.
- Markets for nonvirgin building materials have not fully matured. These markets are in transition from strictly local to national and international. Therefore, it is diffcult to predict the type, percentage, and value of recovered materials an owner might expect with a particular disposal project if similar projects have not been performed in that area.

Recommendations

Several factors are critical when determining the feasibility of dismantlement. The following recommendations are based upon information gained in the case study described in this paper. Working with the contractor on these issues should result in benefits to the owner in decreased landfill volumes and costs, as well as increased proceeds or credits for the recovered timber.

1. Timber dismantles and recyclers are not metal salvagers or hazardous waste abatement contractors, and they are typically not setup as a business to act as a general contractor, who can effectively subcontract other disposal activities.
   Recommendation: Building owners should prepare a building for dismantlement by contracting directly for all other necessary disposal activities.
2. Although not recyclable itself, roofing offers protection of flat assets (decking and flooring) from precipitation and subsequent buckling.
   Recommendation: Do not "help" the timber-dismantling contractor by removing the roofing materials prior to dismantlement.
3. The timber-dismantling contractor requires adequate performance time to maximize the volume of material recovered.
   Recommendation: A good rule of thumb is to allow twice as long a performance period for dismantlement as is necessary for demolition.
4. Allowing the contractor to process and store materials on site (within reason) minimizes handling and transportation costs.
   Recommendation: Provide the timber-dismantling contractor with adequate room to lower, sort, clean, and store recovered materials.

Summary of findings

The following key points summarize the findings of this case study:

1. Dismantling existing buildings and recycling timber and lumber elements reduce short-term disposal costs by reducing demolition landfill volume.
2. Dismantlement, and the resultant recycling of timber and lumber elements, reduces landfill use and should therefore reduce potential long-term liability associated with landfill contribution, should the cost of maintenance or remediation be assigned to past users.

3. Proceeds an owner can expect to receive from recycling timber and lumber may not cover the cost to completely remove and dispose of a building. However, the proceeds can provide a subsidy against those costs.
4. Recycled timber and lumber are being used where there is a demand for certain old-growth wood products, both as structural elements in new timber-frame structures and nonstructural elements such as millwork.
5. The growing market for recycled timber and lumber should result in a decision by owners and contractors to recycle rather than landflll, as outlets for these materials become less speculative. Concurrently, the price or credit owners and contractors receive in the marketplace should increase.
6. Grading standards for nonvirgin materials should be developed and adopted to facilitate the marketability and maximize the value of nonvirgin timber and lumber, which will in turn make recovery and recycling more feasible.