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Alameda County Waste Management Authority
1537 Webster St.
Oakland, CA 94612

Dear Ms. Soll:

Subject: Building 802 Deconstruction Project – Deconstruction Results Report

Introduction

This letter report summarizes the results of the project to deconstruct and salvage materials from the Port of Oakland's deconstruction of Building 802 at the former Oakland Army Base (OAB). The deconstruction review team comprised of the Port of Oakland, the City of Oakland and StopWaste.Org identified building 802 as a pilot project for deconstruction that would inform future deconstruction projects regarding compliance with deconstruction goals and efficacy of timber recycling and waste reduction efforts, and could provide proposed Best Management Practices for future deconstruction work at the former OAB. The purpose of this report is to present the resulting data regarding recovery of materials from the building, to describe methods used to recover materials from the building, and to propose Best Management Practices for future deconstruction work at OAB. Deconstruction occurred during the period from April 1 through August 1, 2008.

Construction

Building 802 is one of a series of eight temporary warehouses built circa 1940 by the US Army at the OAB. These warehouses were built to transfer rail and truck shipments to and from ships docked at the various piers and wharves at the Base. Building 802 was a single-story, timber and wood-framed structure having a total area of nearly 265,000 square feet (including the roof over the truck and rail docks). The building was built on a dock-high fill to accommodate rail shipments on one side and trucks on the other. The interior dimensions are 1298 feet by 180 feet (233,640 square feet) with four rows of columns at a 22-foot spacing. The building had a flat, asphaltic roof approximately 20 feet above the floor and a raised, 50-foot wide, wood-truss-supported center section of clerestory windows. Solid sawn wood beams (10"x22") on wood columns (10"x12") supported the remainder of the roof. Virtually all wood in the building was Douglas Fir.

The majority of the value in deconstructing the building was in the 10"x22" beams, the 10"x12" columns, and the 4"x12" roof purlins. All of the large dimensional lumber was marked as "Select Structural" grade. The roof and wall sheathing and wall studs were marked as #1 grade.

Condition

At the time of deconstruction, the building was in very good condition. A few areas of dry-rot were encountered, amounting to less than one percent of the roof and wall structure. With few exceptions, the roof appeared to have been maintained in good condition. Interior and exterior paint was in generally good condition. There was one incident of a roof tear-off laborer putting one leg through an area of dry rot. He did not fall through, but it underscores the need for safety in roof tear-off operations.

Deconstruction

Deconstruction started April 1, 2008 with a hazardous waste abatement effort to remove asbestos-bearing floor-tile-mastic in the offices and bathrooms, asbestos heating-duct insulation, and asbestos-bearing roofing mastic on the firewall parapets. The painted building surfaces were also scraped to remove and capture loose paint. The paint was found to be lead-bearing. Ballasts from the fluorescent lights were also removed as part of the abatement effort. Actual deconstruction began about 2 weeks later with the commencement of roofing tear-off. Roof tear-off, roof sheathing removal, and building disassembly progressed from west to east. The contractor used a crew of 20 to 25 until June 9, when the crew was reduced to about 10. A further crew-size reduction to 3 occurred on July 18. Deconstruction finished August 1, 2008, amounting to four months of work. There was a one-week stoppage early in the deconstruction due to the Port's judgment of an unsafe work practice.

Roofing tear-off and roof sheathing removal continued until about mid June. The contractor used a small gasoline-powered roofing plow to help remove the layers of roofing. However, as is common in the roofing industry, much of the work was done by hand. Loose roofing rock was swept up, shoveled, and removed from the roof. After roofing is removed, and in order to remove each plank of roof sheathing, nails must be pulled. This was done by hand, using a nail puller. After the roofing was removed, a team of nail-pullers moved down the roof in the direction of the purlins pulling each of the sheathing nails installed in the board faces. Unfortunately, not all of the nails could be pulled. Some nails were embedded too deep in the board to get a hold of with a puller. It appeared that approximately one or two nails in 10 could not be pulled. Additionally, toenailed nails could not be pulled. Next, the sheathing planks were pried out of their tongue-in-groove fitting, removed and stacked. Due to the brittleness of the wood and due the toenails, some of the planks would split upon removal. A few others had some dry-rot damage. Since the damaged or defective board fragments were not complete, they could not be recovered for reuse, and instead ended up in the Bulk-grade of small dimension wood that went to a mulch market.

After removal of the roof sheathing, roof blocking was beat out of the way with hammers or picks. Then the 4"x12" purlins were removed using a high-reach forklift. With very few exceptions, the purlins were recovered full-length and intact. Next, the 10"x22" beams were removed along with the columns. The contractor experimented some with techniques to remove the 10"x22" beams. On the first few beams, the beams were cut at the ends to enable quick removal, but shortening the recovered beam by a few feet. However, the buyer of the beams recommended recovering them full-length, in order to recover more value. A technique was developed where bolted and wooden connections were cut, instead of the beams, allowing full-length recovery of the main beams. Once the connections were cut, a high-reach forklift was able to recover the beams without damaging them. After some experimentation, the columns were also recovered full-length. It appears that all of the main beams and columns were recovered for reuse, without major damage.

Wood contained in the trusses, although substantial, was not as big as the main beams and columns. Truss wood was recovered by lowering the trusses to the ground and cutting each wood member just beyond the gusset plates and bolted connections. After removal of the gusset plates, the wood contained within the area of the plates was included in the Bulk wood flow that went to a mulch market. Carefully disassembling the bolted connections would have allowed more of the truss wood to go to a reuse market. However, considering the potential extra revenue from recovering full-length pieces from the trusses and the labor expense involved, the contractor chose the quicker and much cheaper disassembly method of cutting the truss members at the end of the metal connectors. The contractor decided the extra revenue from full-length truss pieces was not high enough to compensate for the on-site disassembly labor due to the relatively small sizes of the truss member pieces (6"x and 8"x) and the less valuable condition of the wood under the connections due to bolt holes. Nevertheless, all the wood in the trusses was recovered either for reuse or for mulch feedstock.

The last major element of the building to be recovered was the walls. Again, the contractor experimented with several methods of disassembly to find the most efficient. Some of the walls had siding removed while still standing vertically. On others, the walls were laid down to the outside with the former interior up. Others were laid down to the inside of the former structure with the exterior siding side up. Wall recovery was very laborious and with much less recovery value than the building roof and frame. This is due to the fact that the 2"x6" wall sheathing boards tend to be shorter than the roof sheathing boards and that they are painted on one side (inside) with lead-based paint. The many doors and windows in the walls make the average length of wall sheathing boards much less than that for the roof.

From the Project Team's observations, the contractor tried very hard to recover both the wall siding and wall sheathing boards for reuse, and most were recovered. However, the amount of labor expense per recovered ton of siding and wall sheathing was disproportionate in comparison to the recovery of the roof and timber frame lumber. The major issue is that it is very hard to recover 1" siding without damaging it due to its brittleness and the fact that there is no practical way to remove nails without gouging each board. That the boards are shiplap also complicates the removal. The boards must be carefully pried up from the sheathing with a thin crowbar. Lead paint on the boards is another major issue affecting their value.

After removal of the siding, nails were pulled from the sheathing boards using a nail puller, as was done on the roof, or with a claw hammer. Not many of the 3"x6" wall studs were recovered due to damage.

Windows on the building were very large and hard to handle with hand labor. The sashes contained many cut lights approximately one foot square and were too fragile to be recovered easily. Window glass went to the landfill (trash) flow. Similarly, the interior firewalls were faced with gypsum wallboard, which was also painted. No market was found for this material.

Ferrous and nonferrous metals were recovered from plumbing and electrical service in the building. However, some of the ferrous metal and virtually all of the nonferrous metal was stolen from the site over the weekends.

Tally of Results

An accounting of the available large and small dimensional lumber contained in the Building 802 structure is presented in Tables 1 and 2, respectively. The counts of the various pieces of wood used in the construction of Building 802 are taken from the building drawings. The weight estimates are derived from density measurements made on loads of recovered lumber from the project. Summing the estimated total amount of wood contained in the building gives 1474 tons. A summary of the materials actually recovered from the building is shown on Table 3. The amount of recovered wood comes very close to the estimate given in Tables 1 and 2. In fact, the recovered amount slightly exceeds the estimate of available material indicating: 1) that the overall wood density estimate was very slightly low, and 2) that the deconstruction contractor got virtually all of the building's wood into recovery. As is indicated in Table 3, most of the wood recovered went to reuse markets. A smaller portion, the smaller dimensional wood that was not recovered for reuse and larger pieces that were damaged or cut, was shipped from the site as a grade referred to as "Bulk" wood, which went to a mulch market.

Table 1 - Large Dimension Lumber - Sizes and Weights[1]
Building 802 Deconstruction

Item	Nominal Dimension	Count	Paint	Weight per Piece (lbs)	Total Weight (tons)
Main Beams	10"x22"x31.8'	216	No	1522	164.4
Inner Beam Column	10"x12"x15'	108	Yes	358	19.3
Truss Column	10"x12"x25'	108	Yes	596	32.2
Beam Column, Ext Wall	6"x8"x18'	108	Yes	165	8.9
Interior Purlins	4"x12"x22'	2773	No	207	287.0
Exterior Purlins	4"x12"x22'	472	Yes	207	48.9
Exterior Beam	6"x10"x10'	108	Yes	113	6.1
Truss Member A	6"x8"x8'	108	No	73	3.9
Truss Member B	6"x6"x9'	216	No	60	6.5
Truss Member C	6"x12"x27'	108	No	383	20.7
Truss Member D	6"x8"x50'	54	No	458	12.4
Truss Member E	6"x12"x53'	54	No	751	20.3
Truss Bracing A	6"x8"x22'	59	No	202	6.0
Truss Bracing B	3"x6"x44'	59	No	134	4.0
Truss Bracing C	3"x4"x52'	59	No	101	3.0
Total					643.4

1) Weights estimated from densities measured on loads of main beams and purlins.

Table 2 - Small Dimension Lumber - Sizes and Weights[1]
Building 802 Deconstruction

Item	Nominal Dimension	Paint	Total Weight (tons)
Roof Sheathing	2"x6"	No	488
Roof Blocking	3"x12"x3.7'	No	29
Exterior Wall Sheathing	2"x6"	Yes	111
Exterior Wall Siding	1"x6"	Yes	55
Exterior Wall Studs	3"x6"x16' avg	Yes	34
Interior Fire Walls	2x6 w/ 1x sheathing	No	43
Doors - Cargo and Personnel	Various	Yes	26
Other Miscellaneous[2]	Various	-	45
Total			831

1) Weights estimated from density measurements for loads of 2x6 sheathing
2) Estimate for mudsills, headers, blocking, window and door frames, and other interior framing for bathrooms, offices, and cargo areas.

Grand total 834.0

Table 3 also indicates the other materials generated by the project. Ferrous metal and concrete are commonly recovered from most demolition projects. However, on this project, the contractor attempted to recover some other, uncommon materials. These include roofing rock, which was taken by a landscaping contractor, and roofing paper, which went to paper recycling. Both the roofing rock and roofing paper were very laborious to separate. Nevertheless, the contractor was able to get some. Total recovery from the entire building, expressed in percentage terms, amounted to 73.4 percent of the total generated. Therefore, 26.6 percent went to landfill.

An analysis of the recovery of each of the various materials separately is presented in Table 4. The upper portion of this Table looks at the various categories of wood used in this report. The large dimension wood, itemized on Table 1, indicated that 98.1 percent was recovered for reuse. Most, but not all the sheathing and siding were recovered for reuse. The portions not recovered for reuse were recovered in the Bulk grade. Other small dimension wood was also recovered as Bulk grade. On the Table, small dimensional wood was recovered at a higher rate than occurs in the tally for the building's construction because the damaged pieces of large dimensional wood, sheathing, and siding, which could not be recovered for reuse, were shipped off of the site included in this grade and used to make mulch. To recap, all of the wood in the building was diverted from landfill, either through recovery for reuse, or through the Bulk grade.

All of the concrete and ferrous metals produced on the site were also recovered, as is indicated in Table 4. However, this does not include the stolen metal. Of the materials sent to landfill, asphaltic roofing accounts for the vast majority, along with smaller amounts of painted gypsum wallboard and broken window glass.

The amount of roofing material coming from the site, as deduced from the landfilled material weight measurements, is consistent with expectation for the type of roof on Building 802. We would expect a roofing weight of about 5 lbs/ft^2. Taking out estimated amounts for gypsum wallboard and broken glass yields a result close to the expected generation for the roofing. It appears that the contractor has been honest about the material flows reported as part of this project, including those sent to landfill. Moreover, the amount of roofing rock recovered amounts to just under one pound per square foot of roof, which seem consistent with our judgment for the amount of loose, recoverable roofing rock observed on the roof.

Table 3 - Summary of All Materials Produced[1]
Building 802 Deconstruction

Material Type	Weight: Tons	Weight: Percent	Destination or Reuse: Recovery	Destination or Reuse: Type or Receiver	Recovery Percent	Disposal Percent
Wood Large Dimension	630.9	26.1	Yes	Reuse		
Roof and Wall Sheathing	502.3	20.8	Yes	Reuse		
Wood Small Dimension	343.0	14.2	Yes	Mulch		
Wood Siding (1x6) Exterior[2]	42.0	1.7	Yes	Reuse		
Total Wood	1518.2	62.8				
Ferrous Metal	135.1	5.6	Yes	Recycler		
Concrete	108	4.5	Yes	Concrete Crusher		
Roof Rock	10	0.4	Yes	Landscaping		
Roofing Paper	3.2	0.1	Yes	Paper Recycler		
Mixed Materials to Landfill[3]	644.2	26.6	No	Landfill Disposal		
Grand Total of All Materials	2418.7	100			73.4	26.6

1) Does not include ferrous and non-ferrrous metals stolen from deconstruction site.
2) Not weighted, estimated by contractor, hauled daily by Men of Valor to their storage yard.
3) Primarily asphaltic roofing material, painted gypsum wallboard, broken window glass, and painted wood.

Markets

Buyers or receivers (reusable, painted wood was given away) of the various materials produced from the deconstruction are listed in Table 5. As is indicated, there were a number of buyers of the large dimensional wood. The roof and wall sheathing went to a buyer in Mexico. The laborers working for the Project's deconstruction training program took much of the wall siding. The remainder of the small-dimensional wood (which included damaged and broken pieces of larger dimensional wood) went to a local wood mulch market.

Concrete went next door to the Port's Materials Management Site on former OAB property. Ferrous metal went to Schnitzer Steel, a local metal recycler. The landfilled material went to Vasco Road Landfilll in Livermore.

Table 5 - Receivers of Materials
Building 802 Deconstruction

Material	Receivers
Wood - Large Dimension	Vintage Timberworks, Temecula, CA Crossroads Recycled Lumber, North Fork, CA Duluth Timber Co, Duluth, MN Rhine Demolition, Tacoma, WA J Hoffman Lumber, Sycamore, IL
Wood - Roof and Wall Sheathing[1]	Madereria y Ferreterea Sanchez, Mexicali, Mexico
Wood Siding (1x6) Exterior[1]	Men of Valor, Oakland, CA
Wood - Other small dimension[2]	Earthtones Mulch, Newark, CA
Ferrous Metal	Schnitzer Steel, Oakland, CA
Concrete	Adjacent Concrete Recycler
Roofing Paper	Unknown
Roofing Rock	Unknown landscape Company
Trash	Vasco Road Landfill, Livermore, CA

1) Some of the sheathing and siding was rotten or broken and ended up in the wood bound for mulch markets

Conclusions

Large Dimensional Lumber

The large-dimensional lumber from this deconstructed building received a considerable amount of interest from reused lumber distributors. The actual revenue that came from the sale of large dimensional lumber was not available to the Project Team. However, an estimate of the value of the large dimensional lumber in each 800-series building at the former OAB is about $500,000, or $700 to $800 per ton, not including trucking expenses. 98% of the large dimensional wood from Building 802 was recovered and sold in a form for reuse. The remainder was recovered in a broken form for mulch.

Metal

Metals also have salvage value and recovery of metal is common for the demolition/deconstruction industry. At the time of the project, metals were worth about $100 per ton. Metal from electrical conduit and fire sprinkler piping was removed in-place or was cut in-place so as to enable the recovery of large-dimension timbers without damage. Because of these two factors, metal salvage was prudent for this project. Virtually all of the metal in the building was recovered, although most of the non-ferrous metal and a small fraction of the ferrous metal were stolen from the site.

Table 4 - Recovery by Material
Building 802 Deconstruction

Material	Estimated Available Tons	Measured Generation Tons	Recovery Fraction Percent	Market
Wood - Large Dimension	2.9795	630.9	21174.7	Reuse
Wood - Roof and Wall Sheathing	599.0	502.3	83.9	Reuse
Wood Siding (1x6) Exterior[1]	55.0	42.0	76.4	Reuse
Wood - Other small dimension[2]	177.0	343.0	193.8	Mulch
Total Wood	833.9795	1518.2	182.0	
Ferrous and Non-ferrous Metal	na	135.1	appx 100	Recycling
Concrete	na	108.0	appx 100	Recycling
Gypsum Wallboard - Painted	30	na		
Window Glass	11	657.4	2.0	Landfill[4]
Roofing at 4.7 lb/square foot[3]	616.4	na		
Total for all Materials		2418.7		

1) Not weighted, estimated by contractor, hauled daily by Men of Valor to their storage yard.
2) Large dimension wood, sheathing, and siding that was cut as part of the deconstruction process, damaged, or encountered as rotten, was included with the small dimension wood, which went to a mulch market.
3) Recovered roofing includes 3.7 tons of paper and 10 tons of roofing rock.
4) Landfilled amount is 644.2 tons.
na = not available

Concrete

Concrete was recovered from the building's column bases, was easy to collect separately from the other materials, and had a market a few hundred yards from the site. Although recovered concrete usually has a zero or negative salvage value, concrete recovery is also standard practice for the demolition industry as the cost for disposal is high due to the density of the material.

Small Dimensional Lumber

Roof Sheathing

Virtually all the small dimensional lumber from the building was recovered either in an intact form for reuse, or in a broken form as a feedstock for mulch. Over half of the recovered small dimensional lumber salvaged for reuse was the 2x6 roof sheathing. As was the case with the electrical conduit, these boards needed to be removed with considerable care so as to expose the timber frame and enable removal of the more valuable large-dimensional timbers without damage. Despite the fact that the boards were of good initial quality, in good condition, of considerable length (averaging nearly 20 feet) and not painted, the roof sheathing and other small dimensional lumber received much less interest from salvaged lumber buyers than did the large dimensional lumber. Moreover, the price offered was a fraction of the then current price for new lumber.

This is largely due to two factors: 1) new small dimensional lumber is widely available and is not much more expensive than salvaged lumber at the retail level; and 2) The International Building Code (IBC), upon which virtually all State Building Codes are based, effectively prohibits reuse[1]. In order to reuse savaged boards for structural use, the IBC requires that a qualified official regrade each board. Regrading small dimensional lumber is generally considered cost

[1] IBC (2006) Section 104.9.1: Used material and equipment are required to be evaluated in the same manner as new materials. Similarly, for the residential code, IRC (2006): Used material, equipment, and devices shall not be reused unless approved by the Building Official.

prohibitive[2], which is one of the reasons salvaged lumber is sometimes reused in flooring, which is a non-structural use and does not require regrading. Unfortunately, salvaged small dimensional boards are not often a cost-effective source of flooring due to the need for meticulous denailing and their having more cracks and gouges than do similar-sized new lumber. Thorough denailing and treating or avoiding the additional cracks and gouges increases the cost of producing flooring from the salvaged small dimensional lumber as compared to using new lumber. Because it involves less labor and results in more defect-free surfaces, salvaged flooring boards are frequently made by re-sawing larger timbers rather than milling small dimensional lumber. Another reason there is limited demand for salvaged lumber from flooring producers has to do with the wood species. Douglas fir has a very small fraction of the flooring market. The various hardwoods comprise the vast majority of the market.

A small portion of the roof sheathing boards from this project did get made into flooring but the vast majority was sent for reuse to a buyer from Mexico, whose purchase offer was the highest received by the contractor for that material. The sheathing boards sold for about $100 per ton less trucking expenses, which is one-quarter to one-third the price of new, similar-sized lumber. This price is much higher than that for the wood biofuel market, but considerably less than that for the large-dimensional lumber.

If the unpainted roof sheathing can be recovered in a reasonably good condition, then the salvaged lumber market (reuse) appears to offer substantially more for the boards than does the biofuel market. However, for this project the reuse market for small-dimensional lumber was not local.

Wall Sheathing and Siding

Most of the remainder of small dimensional lumber was 2x6 wall sheathing, 1x6 wall siding, and associated studs. Unlike the roof sheathing, the wall sheathing, siding, and studs were painted. The contractor recovered most of the siding and a small part of the wall sheathing in a condition for reuse. A paying market was not found for the siding or the sheathing. The siding was donated to and taken by the laborers participating in the Project's deconstruction training program. The wall sheathing that was recovered for reuse was also sent to the Mexican buyer.

Economics of Recovery for Reuse

Deconstructing the building's walls in order to recover lumber for reuse was very laborious and yielded lumber for which a paying market was not found. The only exception to this was the large dimensional 6x8 column posts in the walls at the column lines. Assuming a market price of zero, the expense avoided by not landfilling the painted wall lumber from the building was equal to less than the expense for one day of field crew operations. However, the wall deconstruction required weeks of field crew operations time. Moreover, even with considerable care in deconstructing the walls, much of the wood in the walls was recovered in a broken form and went to a mulch market that required a small tipping fee.

From this monitoring project, it is not possible to precisely assess the cost/benefit situation for the recovery for reuse of small dimensional painted wood. Nevertheless, a crude calculation is possible. The total amount of painted wood that was recovered in a condition for reuse was about 80 tons, which is about 40 percent of the total amount of painted wood on the building. The remaining 60 percent was made into mulch. The cost of the effort to recover this wood in a form for reuse in excess of the cost to demolish the painted wood walls for landfill disposal is at least two crew-weeks, likely more. The cost of a crew-week was about $50,000. Therefore, the cost of the recovered wood with paint was at least $100,000/80 = $1,250 per ton and the revenue that came from the painted wood was zero. As a simple example, a new 10-foot long 2x6 currently costs about $4 at local lumber dealers. If the contractor were to sell a 10-foot 2x6 from the project

[2] A purchaser of some lumber for this project, Marc Mandell of Crossroads Lumber, Northfork CA, estimated the cost to regrade 1000 board feet at more than $500. This is $.50 per board foot. The unpainted 2x6 sheathing sold for about $.10 per board foot.

and recover costs, the board would need to sell for at least $12.50. Moreover, it would not be received well by the market since it would have lead-paint, nails sticking out of it, nail holes, and gouges.

It is clear that recovery of the painted wood in the building walls for reuse was not economical (except for the large dimensional column posts and exterior 4x12 roof beams, which may be valuable due to their size).

Liability and Health Concerns

In addition to being uneconomical, using wood with lead-based paint is an issue because of liability and health concerns. Construction debris containing lead-based paint has been historically regulated under RCRA provided it was Toxicity Characteristic (TC) waste and was not exempt as household waste. On July 31, 2000, the EPA Office of Pollution Prevention and Toxics provided clarification to the regulatory status of waste generated by contractors and residents from lead-based activities conducted in households. The clarification allows wastes from residential dwellings "like single family homes, apartment buildings, row houses, military barracks or college dormitories" such as "doors, window frames, painted woodwork, and paint chips" to be disposed of as household waste for the time being. Further clarification by EPA disallowed the household waste classification for military buildings.

While testing for TC on the lead-based paint may not have been done for this project, wood with lead-based paint often does test as hazardous. There is also a movement in the US legal community to seek compensation for damages caused by exposure to lead-based paint in the same manner that been applied to the asbestos industry. From the experience of the asbestos industry, there is a risk of future liability if current practices regarding the handling of wood with lead-based paint are judged to be negligent in the future. Crafting deconstruction contracts that require high rates of diversion from landfill for buildings with lead-based paint raises the question of what is an acceptable market for the painted wood, if any. We recommend that the owner decide what are acceptable markets, if any and include this restriction in the deconstruction contract.

If the owner decides that project economics are not a consideration and that recovery for reuse is a prudent goal for wood with lead-based paint, then labels that clearly disclose the hazard and outline necessary protective measures should be placed on each recovered board. As an example of a disclosure label, the National Paint and Coatings Association (NPCA) and the State Attorneys General have agreed on the NPCA Labeling Guide, which is placed on paint containers. The warning is as follows:

> WARNING! If you scrape, sand, or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a NIOSH-approved respirator to control lead exposure. Clean up carefully with a HEPA vacuum and a wet mop. Before you start, find out how to protect yourself and your family by contacting the National Lead Information Hotline at 1-800-424-LEAD or log on to www.epa.gov/lead.

Treating the painted wood in a way that removes the lead-based paint is an alternative approach to making the painted boards suitable for reuse. There are two common techniques for removing paint from wood. They are: stripping with heat or chemical solvents; and physically removing the paint layer with a planer or molding machine. Both of these techniques are feasible, but would add to the expense of recovering the painted boards.

Hot chemical dip stripping is a common practice for painted wood that is expensive to replace. Costs run about $3 per square foot. For an example 10-foot long 2x6, dip stripping would add about $14 of expense, but would make the board worth roughly what was paid for the unpainted boards, which was $1 to $2. It is unlikely that a large scale operation set up at the deconstruction site would be able to achieve lower costs because of the high labor rate the program would operate under and the matter that much of the cost of dip stripping is the proper handling and disposal of toxic waste that results from the process.

Remilling the boards with a planer or molding machine is likely somewhat cheaper than chemical stripping. Remilling has been used on demonstration projects at several previous military base deconstruction projects. The process has been found to be technically feasible, however, no economic projections have been published for the process.

In order to remill painted lumber, all metal fasteners must be removed. Fastener removal is also a labor-intensive process. We found on this project what has been found on past projects. That is, even with experienced crews removing nails and other fasteners, many are missed. Some nails may have broken or corroded and cannot be seen. Sometimes the head is obscured. Sometimes the laborer simply did not see an occasional fastener. These fasteners cause rapid wear or damage to the equipment used to plane or mill the boards so it is imperative to remove them all. For these reasons, use of a magnetic detection system is a must.

Cost for remilling boards would depend strongly on how thoroughly the fasteners and other abrasive grit were removed. An additional cost is the disposal of the molder or planer cuttings, which would certainly test as hazardous material. Planing or milling of new lumber usually costs from $0.2 to $0.5 per lineal foot. Planing or milling lead painted wood would be much more abrasive to the cutting blades and would have higher costs. Using our example 10-foot long 2x6, it is unlikely that thorough denailing, magnetic testing, planing, necessary handling, and hazardous waste disposal could be accomplished for less than $5 per board. If planed to remove the paint layer, our example 10-foot long 2x6 would be worth $1 to $2. It is likely that some other molded shapes would be worth more than a planed 2x6. Use of a four-head molder could make moldings worth much more than a planed 2x6 board. However, more expense would be required to produce the molded shapes. As far as we know, no molded shapes were produced from the small dimensional lumber that came from this deconstruction project.

Table x presents a crude attempt to assess the economic cost/benefit of recovering and stripping paint from the painted wood so as to make the boards feasible to reuse in an unpainted form. Considering the strongly unfavorable economics of recovering lead-painted wood, the potential of future liability, and the possibility that, under RCRA, lead painted wood from former military building may a hazardous waste, it makes sense to demolish the walls and haul the lead-painted wood to landfill.

Broken wood that is not painted would certainly be suitable for both the biomass-to-energy and mulch markets. Since the energy market pays a positive price for its feedstock, when properly prepared, and the mulch market offers a lower price, it is worth investigating the energy market for unpainted, broken wood. If an energy market is available, then it makes sense to collect the broken, unpainted wood from the deconstructed areas before demolishing the walls, so as not to mix painted and unpainted wood. From this project, the unpainted, broken wood came primarily from roof sheathing that fractured on removal, roof blocking, beam and truss bracing, cut-up truss pieces, and the building's interior firewalls (studs and sheathing beneath the painted wallboard). Both the biofuel and mulch markets require wood that is clean and free of nails and any other metallic or non-metallic items. With the relatively high hourly labor rates for the deconstruction contractor, it is likely that an off-site processor would be more economical for the sorting and shredding of broken wood to mulch or fuel specifications.

Other Materials

The following materials were encountered in the building deconstruction and were sent to landfill:

Painted Wallboard

The Deconstruction Project Team is not aware of any market for painted wallboard (aside from ADC and beneficial reuse, see description below)

Window glass

There is a market for window glass; however, costs involved would certainly exceed the value of the recovered glass. In order to recover the glass, the individual panes of window glass would need to be removed from the sashes, as one would do to replace a broken windowpane, or broken out of the sashes over a collection container. The labor expense required to recover glass for recycling by these methods would vastly exceed the value of glass recovered. Alternatively, a mechanical process could be developed to enable recovery of broken glass using entire window sashes as a feedstock. While the Project Team is aware of equipment that could separate the glass from wood, glazing compound, paint chips, and nails, once the window and frame have been smashed or shredded, purchasing or renting that equipment plus the labor involved would certainly exceed the value of the recovered glass.

A potential problem with any window glass recovery scheme would be glazing compound that contains asbestos. If the glazing compound is asbestos-bearing, we do not recommend attempting to recover the glass.

Roofing

Roofing accounted for most of the materials hauled to landfill. Despite the contractor's valiant effort to recover some of the roofing (some roofing paper and the loose roofing gravel were recovered), there is presently no local market for waste asphalt roofing. Most of the roofing gravel adhered tenaciously to the asphalt, fabric, and paper matrix. Recovery of a portion of the roofing gravel that was stuck to the asphalt does not appear to be feasible on a large scale without shredding, screening, and air classifying equipment. The Project Team is not aware of anyone putting equipment together that can accomplish this task for the hot-mopped, built-up type of asphalt roofing used on the 800 series buildings. Attempting this would certainly be an experiment.

There have been reports of a few operations in the Eastern US that attempt to recover asphalt from some waste roofing products, primarily three-tab asphalt shingles. However, there are none in the Western US. For the present, it appears that roofing materials would need to be landfilled.

Table 6 - Recovery Alternatives and Values for Each Material
Building 802 Deconstruction

Material	Form	Market	Value[1] ($/ton)
Large Dimensional Lumber - Unpainted	Intact	Reuse	400 to 1200
Large Dimensional Lumber - Unpainted	Broken	Biofuel[2]	-20 to 15
Large Dimensional Lumber - Unpainted	Broken	Mulch	-30 to 0
Small Dimensional Lumber - Unpainted	Intact	Reuse	unknown
Small Dimensional Lumber - Unpainted	Broken	Biofuel[2]	-20 to 15
Small Dimensional Lumber - Unpainted	Broken	Mulch	-30 to 0
Small Dimensional Lumber - Painted	Intact	Reuse	unknown
Small Dimensional Lumber - Painted	Broken	Mulch or Landfill	Landfill Fee to -10
Ferrous Metal	Bulk	Recycling	20 to 40
Concrete	Broken	Recycling	-50 to 0
Glass	Bulk	Recycling	-20 to 0
Painted Gypsum Wallboard	Bulk	Landfill	Landfill Fee
Asphalt Roofing	Bulk	Landfill	Landfill Fee

1) Estimated, excluding hauling fee.
2) Requires shredding, screening, and magnetic separation to meet biofuel specifications. Lower prices for wood as-is, high prices for wood prepared to biofuel specifications.

Alternative Daily Cover (ADC)

It would be technically feasible to run any of the materials for which there are no markets through a shredder so as to satisfy the State requirements for Alternative Daily Cover (ADC). Moreover, it may also be economically feasible. There have been instances of fee discounts negotiated at some landfills in the Bay Area for this type of material. However, the Project Team does not know if the ADC discounts would be large enough to justify the expense of shredding the materials to ADC specifications.

Table 7 contains a summary of the various forms in which the materials could be recovered and their approximate values.

Recommendations

Recommendations for materials handling and markets are presented in Table 8. Considering project economics and potential liability and health risks, the major recommendation is to not recover lead-painted wood. Lead painted wood should be collected separately from non-painted wood and sent to landfill.

Another issue that came from this project is a matter for research. It is the issue of regrading and the lack of local markets found for the small-dimensional lumber recovered for reuse. If the recovered lumber from a deconstruction project were regraded, then it would be available locally for the same use it was originally put to, structural use, as well as for non structural uses (flooring or decorative uses). This would be in keeping with the highest and best use hierarchy and would increase the number of potential uses for the lumber. Most of the small dimensional lumber for this project was shipped to a buyer in Mexico, where regrading may not be required. We recommend investigating the issue of regrading deconstructed lumber. Anything that can be done to reduce the cost of regrading could increase the local demand for recovered wood as lumber, rather than as lesser value products, such as feedstock for biofuel or mulch.

Table 7 - Schedule of Materials for Recovery or Landfill Disposal

Material	Painted	Activity	Comments/Actions
Loose Roofing Rock		Recover loose roofing rock	Recover in-place on roof.
Remainder of Roofing		Roofing tear-off	Send to landfill. Beware of fall-through risk due to areas of dry-rot.
Roof Sheathing	No	Recover for reuse	Remove all face nails. Pry boards from tongue-in-groove fitting and toe-nail fastenings. Remove with care so as to recover as many boards as possible. Recover broken and rotted boards in bulk form.
Roof and Truss Blocking and Bracing	No	Remove and recover in bulk form for biofuel or mulch	Remove with care so as to enable recovery of the timber frame. Keep separate from painted wood.
Electrical Conduit and Sprinkler Piping		Remove in-place and/or on ground	Recover for metals markets.

Large-dimensional Lumber				
	Roof Purlins	No	Recover for reuse	Do not damage. After main beams and columns, second largest source of revenue.
	Main Beams	No	Recover for reuse	Cut the connections, not the beams. Recover full-length. Largest source of project revenue.
	Trusses	No	Recover as much as feasible	Recover truss members full-length or cut off at end of metal strap/gusset plate connections.
				Recover wood under connections and short pieces as bulk wood.
	Interior Columns	Yes	Recover for reuse	Cut the connections, not the columns. Recover full-length. Apply lead-hazard labels.
	Wall Columns	Yes	Recovery for reuse optional	Apply lead-hazard labels if recovered.
	Dock Roof Beams and Purlins	Yes	Recovery for reuse optional	Apply lead-hazard labels if recovered.
Window Sashes, Frames, Trim, & Clerestory Siding		Yes	Demolish	Send to landfill. Keep separate from unpainted wood.
Exterior Walls including Sheathi Siding, Studs, and Blocking		Yes	Demolish	Send to landfill. Keep separate from unpainted wood.
Dock Roof Sheathing		Yes	Demolish	Send to landfill. Keep separate from unpainted wood.
Firewalls - Painted Wallboard		Yes	Tear-off wallboard	Landfill painted wallboard.
Firewalls - Studs and Sheathing		No	Recover in bulk form	Keep separate from painted wood.
Cargo Doors		Yes	Recover for potential use	Investigate potential uses. Apply lead-hazard labels if recovered.
Interior Office Spaces		Yes	Demolish	Landfill
Weigh Scale			Remove and Recover	Recover for metals markets.
Concrete		Yes	Remove column bases	Conventional concrete recovery

Please call or write if you have any questions.

Sincerely,

Matthew J. Southworth, P.E
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