ECONOMIC EVALUATION OF ALTERNATE MATERIALS TO TREATED WOOD IN CALIFORNIA

prepared for

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optimizing environmental resources - water; air; earth

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EXECUTIVE SUMMARY

Legislation and/or regulatory changes are being considered in California that could prohibit the use of new treated wood products. In addition, some Federal, regional and local regulatory agencies have expressed concern with treated wood and suggested that economically viable alternative materials are available and should be used. Treated wood alternatives include steel, concrete, plastic, and composite materials manufactured to perform the same end use as the treated wood products. The logical question is how economical are these alternatives on a project basis and what would be the overall impact of using alternatives. This paper seeks to address these important questions.

The alternatives to treated wood products usually cost more to purchase and more to install than treated wood. The increase in installed cost generally ranges from about 50 percent to 200 percent more than treated wood. In California, about $1.0 billion is spent annually in projects using treated wood. It is estimated that the cost of the same work would increase by about $2.4 billion to a total of about $3.4 billion annually. Increased costs would impact wide segments of the California economy, including the following:

- Residential and commercial construction costs increase by about $1.1 billion per year.
- Utilities pole costs increased by about $100 million.
- Railroads would be forced to replace existing systems at a cost of about $960 million per year for the next 10 years while also increasing tie replacement costs by about $45 million per year.
- Marine construction cost would increase by about $130 million per year.
- Road and highway transportation agencies costs would increase by $6 million annually.

Further, indirect cost and impacts would be likely as the alternate products may not perform as well as treated wood or result in higher operational or maintenance costs. Use of unproven materials or construction methods could result in accidents, injuries, and/or loss of service by utilities or railroads.

1. INTRODUCTION

Preservative treated wood is used widely throughout California and the world. Creosote has been used to preserve wood since the late 19th century and was critical to the successful development of the railroad transportation system that benefits all today. Other preservatives entered the marketplace in the 1950s with numerous improvements over the years. Treated wood products are now common in uses such as utility poles, railroad ties, pilings, sign and guard rail posts, fencing, outdoor decks, public boardwalks, foundation sill plates, and agricultural supports. These uses have become common because wood is a strong, flexible, economic building material that, when treated, will last a long time in moist and/or outdoor environments. In fact, depending on the severity of the use and environment, treated wood lasts for more than 20 years and often as long as 100 years.

Legislation has been introduced in California that would prohibit the use of most treated wood products, including nearly all that are now common. An assumption of this legislation is that alternatives to treated wood are practically and economically available. In addition some Federal, regional and local regulatory agencies have expressed concern with treated wood and suggested that economically viable alternative materials are available and should be used. The purpose of this paper is to evaluate the economics of changing from the established treated wood products to alternative products.

Alternatives to treated wood vary according to the uses. For residential outdoor construction, such as for decks, fences, and landscaping, products manufactured from recycled plastic or plastic wood composites have entered the market. Such products allow the homeowner a very similar end product, such as an elevated deck and railing system. Other alternatives involve alternate, but quite different, end products. For example, a concrete patio at grade rather than an elevated deck offers similar use, but provides a significantly different aesthetic feel. Alternatives to treated wood utility poles include steel, concrete, and fiberglass poles. Alternatives to treated wood railroad ties include concrete, steel, plastic, and composite materials. Treated wood piling alternatives include steel, concrete, and plastic products.

In all cases, the alternative materials involve tradeoffs in structural qualities, cost, and effectiveness. The costs resulting from the transition to alternate products to the end users in California are evaluated in the following sections of this paper. To the extent the data is available to this author, both the direct costs of the different materials and the associated indirect costs resulting from different structural or physical properties are considered.

Each significant market area will be evaluated separately. Evaluations identify typical or representative product installations, estimate the costs using treated wood and alternative products, and project those market costs statewide. These market costs are totaled to represent an overall economic impact to California.

2. CALIFORNIA TREATED WOOD MARKET

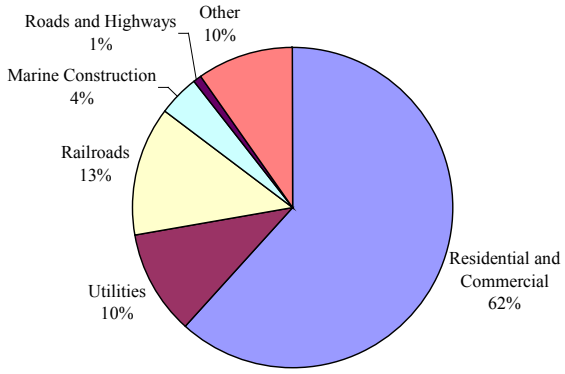
In a previous paper by this author (Smith, March 2003), a method was developed to estimate the amounts of treated wood sold annually in California using national and regional treated wood industry statistics. Conclusions of that paper form the partial basis of many of the projections made in this paper. For example, annual sales of treated wood in California represent about 7 percent of the total U.S. sales and are estimated to be:

- Water Borne Treated Wood 34,541,000 cubic feet
- Oil Borne Treated Wood 2,514,000 cubic feet
- Creosote Treated Wood 6,473,000 cubic feet
- Total California Treated Wood Sales 43,528,000 cubic feet

Industry statistics are used to estimate the fraction of treated wood used in each market. These fractions are applied to the California market on the assumption that national trends are applicable at the state level. Further refinement of market estimates involves professional judgement to estimate the fraction of a product that may be used by a particular market segment. For example, this author estimates that 80% of treated timbers are used in the residential and commercial outdoor market, 5% in the railroad market, 5% in the marine construction market, and 5% in the roads and highways markets.

Using the volume estimates above and industry statistics (Micklewright, 1998), the volume of treated wood used in the major markets of California are estimated in Table 1 and shown graphically in Figure 1 below.. These estimates show, for example, that approximately 62% of the treated wood used in California is used in the residential and commercial outdoor construction market. Note also that estimates for the major markets account for approximately 90% of the total volume and about 10% of the market is included in the "other" category.

Figure 1
California Preserved-Wood Markets Summary



3. CONSTANTS AND CONVERSION FACTORS

Constants and conversion factors used in the calculations are listed in Table 2 for the convenience of the reader. The wood preservation statistics report the volume in actual cubic feet of treated wood. Lumber and timber volumes are also often reported on a nominal basis. For example, a 2 by 4-inch piece of lumber has actual dimensions of 1-5/8 by 3-1/2 inches. The nominal and actual cross sectional areas are 8.00 and 5.69 square inches, respectively. The nominal volume is 1.4 times (8/5.69) the actual wood volume. One cubic foot (cf) is equal to 12 board feet (bf). Allowing for the increase to nominal dimensions, one actual cubic foot of treated wood will equal about 17 nominal board feet of lumber. (1.4 x 12 = 16.8). For water borne preserved wood, which is mostly lumber, this factor is used. For creosote and oil borne preserved wood, which are mostly poles and ties that are typically reported in actual size, an actual to actual factor of 12 board feet per cubic foot is used. The derivation of these factors is included in Table 2.

4. RESIDENTIAL AND COMMERCIAL CONSTRUCTION

4.1. Market Description

Residential and commercial construction includes sill plate, exposed strurctural supports, outdoor stair systems, decks, fences, boardwalks, and landscaping constructions, such as low retaining walls and planters. Most of this construction is made of chromated copper arsenate (CCA), ammonical copper quat (ACQ), copper azole or other waterborne preservative treated wood. As shown in Table 3, the current market is estimated to be about 26.9 million cubic feet or 457 million board feet per year, representing about 62% of the California treated wood market. This consists primarily of about 20,500,000 cubic feet or 350,000,000 board feet of lumber with lesser amounts of structural and landscape timber, fence posts, and specialty products.

4.2. Evaluation

Treated wood is used in a wide range of applications that are much too varied to allow a detailed evaluation of each. For this paper, typical applications are considered that represents a large fraction of the total outdoor market. The first is a residential deck. The whole building system must be considered in order to have a complete evaluation, including the support structure and railings.

Fencing is considered as the second application. However, based on phone calls to several lumber retailers, including major chains, it was determined that treated wood is not commonly used for fencing boards in California. Generally, the typical one by six lumber for fencing is redwood or cedar. Treated wood is used most commonly for the fence posts and framing.

The typical deck applications will illustrate the cost implications of requiring alternatives to treated wood for future construction. Fencing is also considered.

4.3. Alternate Materials

The alternatives to treated wood for outdoor deck and railing systems include plastic and plastic/wood composite building materials. A number of manufacturers now offer “plastic lumber” that is made from recycled plastic. While offering a look similar to wood, the alternate materials have different structural properties that must be addressed. For example, the plastic has lower modulus of elasticity (about 60,000 psi) than wood (about 1,400,000 psi). For a similar design load, the plastic decking will require closer spacing of the supporting joists. Plastic lumber is not suitable for structural applications, such as posts, joists, and beams unless reinforcing fibers are added during the manufacturing process. Engineered Plastic Systems, LLC offers both non-structural plastic and structural plastic wood alternatives.

Naturally decay resistant wood species have historically been the alternative to treated wood. While redwood and cedar are currently available, their supply is not believed adequate to be a complete alternative. Concerns about preserving the existing stands of Redwood and continued harvesting of available wood will probably result in lower availability and higher cost in the future. Newer, “second growth” trees with a higher proportion of non decay resistant

sapwood and less dense heart wood does not offer the degree of natural resistance found in the traditional products sawn from old growth timber.

Concrete remains an alternative. For decks that are low to the ground, on-grade concrete slab construction may be considered. However, the aesthetics of concrete are much different than wood. For elevated decks, concrete is also an alternative, but at significantly more cost and construction complexity.

It is important to remember that the supporting structural framework for decks should not be untreated wood. Safety and most building codes compliance requires that treated wood or other materials resistant to weathering and decay is used. Deck failures and injuries have resulted from use of untreated wood structural members that decayed.

Redwood, cedar, plastic and composite lumber products are available for fencing. Structural components of fencing, such as the posts and rails, must be treated wood, redwood or cedar, fiber reinforced plastic, or other alternate materials such as steel.

4.4. Cost of Alternate Materials

The costs of building a typical deck with treated wood and alternate products are calculated in Table 3. The cost of materials for a deck of 15 by 30 feet would cost about $1,425 if made of treated wood. Materials for the same deck would cost about $4,000 to $6,000 if composite or plastic building materials were used, roughly 3 to 4 times the treated wood cost. The deck would use 1,745 board feet of treated wood for a unit cost of $0.82 per board foot.

The unit prices for treated wood and alternate materials were obtained from a variety of sources. The author called building supply stores in California to obtain prices for treated wood and composite materials. Information and pricing was obtained from web sites for the recycled plastic lumber products. Means 2002 was used for concrete pricing.

A concrete patio may be substituted for a wood deck. If it were installed on grade and without an architectural finish, the cost would be about equal to treated wood. However, addition of an exposed aggregate finish would increase the cost to a level similar to the other alternate materials. If an elevated deck were needed, concrete construction would be more expensive than the plastic or composite alternatives.

The costs of fencing materials are shown in the last part of Table 3. Redwood and cedar are typically used. Treated wood fence boards are generally not used in California. Fence posts and railings may be treated wood, redwood, or cedar or may be reinforced plastic or composite. The ratio of cost of fencing with alternate materials to treated wood is shown to be similar to the ratio for deck construction. The structural members of fence systems will be similar in cost comparisons to the decking analysis.

The statewide cost of construction with composite and/or plastic materials can be roughly estimated as shown at the top of Table 3. Using the calculated numbers above, assume the typical unit cost of treated wood construction materials at $13 per cubic foot (about $0.76 per board foot) and alternate material cost factor of 3. The value of treated wood sales to the residential and commercial outdoor market is about $565 million. The cost to California for the

same projects using alternate materials would be about $1.7 billion for an increase of about $1.1 billion per year.

This analysis has not included labor and other installation costs. Since the plastic and composite materials can generally be installed with similar equipment and methods, the installation (labor) cost for most typical projects are assumed to be the same for the alternate materials.

5. UTILITIES

5.1. Market Description

Treated wood is used in the utilities market for poles and cross arms. Most poles are treated with pentachlorophenol, although significant numbers are also treated with other oil borne preservatives, waterborne preservatives, and creosote. Poles and cross arms are used to support electrical and communication wires. Treated wood sales to the California Utilities market is estimated to be 4.5 million cubic feet per year and account for about 10 percent of the California treated wood market.

5.2. Evaluation

Poles are identified by length and class. For example, a 45-foot class 4 pole is a common size. The class rating relates to the diameter of wood poles and, therefore, its load carrying capacity. Alternate material poles are available and also identified by length and class. However, wood poles and steel or concrete poles of the same length and class are not necessarily interchangeable. See RUS Guidelines, October 2002 and information on the WWPI web site for an explanation. In evaluating suitability and cost of alternate materials, these factors must be considered.

This cost evaluation is based on an "average" pole and applies that to the whole California market. While this author recognizes that poles of a range of sizes and classes are used for various applications and needs, the average is used simply as a tool to develop a reasonable estimate of the overall market.

5.3. Alternate Materials

The primary alternatives to treated wood poles include thin-wall and light-duty steel poles, spun concrete poles, and fiberglass poles. Various options for cross arms and hardware are also available. Although mechanical lifts are now more frequently used to access the pole top areas for work, most utilities require that non-wood poles have steps for climbing in emergency situations. Steps are not required for wood poles since linemen may use climbing spikes. Typically, steps are field attached to the poles that have pre-installed provision for mounting steps included as part of the original pole.

Design and installation to prevent electrocution of raptors has become important to California utilities. While this applies to all pole types, the cost is more for the conductive steel and concrete poles than for non-conductive wood or fiberglass.

5.4. Cost of Alternate Materials

Costs for the "average" pole of treated wood and alternative materials are estimated in Table 4 (Harness 2000 and personal communications). The average treated wood pole installed cost is about $800. Similar sized alternate poles cost about $1,650 for fiberglass, $1,320 for thin wall galvanized steel, and $1,550 for concrete. Installed, alternates cost about 1.6 to 2 times the cost of treated wood. The annual cost increase to California would be about $90 to $145 million for new and replacement poles.

Shaw and Kiser, 1999, evaluated the costs of wood, steel, and concrete for a specific project in North Carolina. One hundred ten (110) 50- and 55-foot long poles were required. The total installed cost for concrete and steel would have been about three times higher than for treated wood poles. Similarly, WWPI, March 2003, found similar results with delivered material costs for steel about two times and for fiberglass about three times higher than for treated wood.

The cost increase is significant, but actually small compared to other potential related cost impacts. The cost of pole structures is estimated to be only 15 percent of the total for an overhead power line system (WWPI 1997). Utilities have considered alternate materials over the years, but have consistently decided that treated wood is the best material for the majority of their needs. Regarding the use of non-wood poles, one California utility cited the following concerns to this author (personal communication):

- They do not use thin wall steel due to concerns of electrocution, potential reduced pole life due to corrosion, and potential cost and liability of injuries and service disruption resulting from pole failure.

- Concrete is not used because of added costs of transportation and installation that result from the extra weight.

- Some fiberglass poles have been installed experimentally. Fiberglass poles are not generally selected due to lack of proven long term reliability and due to increased costs that relate to difficulty of field modifications and repairs and worker ergonomics.

- The utility prefers to purchase materials from which the manufacture results in the least generation of greenhouse gases. Wood products result in lower emissions than steel, concrete, and fiberglass.

- Fiberglass and steel poles are more subject to accidental or intentional damage. If damaged, repairs are more difficult and expensive. Such damage is more likely to result in pole failure.

6. RAILROADS

6.1. Market Description

Treated wood is used for railroad ties that support the rails in the railroad market. Cross ties are 8.5-feet or 9.0-feet long and placed at regular intervals for the whole length of a railroad system. Switch ties are longer to provide the wider base where switches are installed in the rail system. Bridge ties are installed under the rails on bridge structures. Treated wood timbers or glue-laminated beams may also be used in bridges. Nearly all wood used in the railroad market is treated with creosote.

Treated wood sales to the California railroad market are estimated to be about 5.6 million cubic feet or the equivalent of about 1.5 million ties per year. The value of these sales is about $42 million per year. The railroads account for approximately 13 percent of the California treated wood market.

The California Railroads (California Railroad Industry, March 28, 2003) report the following California statistics:

- The Union Pacific has over 6,152 miles of track.
- The Burlington Northern & Santa Fe has 3,724 miles of track.
- Track uses about 3,200 wood ties per mile.
- Approximate costs for ties and installation are about
  - Wood ties: $90 to $100.
  - Concrete ties: $160 to $180.
  - Composite ties: $110 to $130, although long term performance not yet proven.

The Railway Tie Association (RTA, private communication) provided additional information:

- 31 Railroad companies operate in California.
- The average, annual tie replacement rate is about 2.5 percent of ties per year.
- Above replacement rate does not include new construction work by the railroads. For example, in rebuilding UP's Roseville, CA yard, about 500,000 ties were used in year 2000.

Thus, with the UP and BNSF accounting for nearly 10,000 miles of track in California alone, a conservatively low estimate of total railroad track in California of 12,000 miles is used. Based on 3,200 ties per mile, this would account for approximately 38.4 million ties or about 140 million cubic feet of treated wood ties.

6.2. Evaluation

Any alternative material to treated wood must be considered as part of the overall rail system. The cross tie is a part of the rail system that interacts dynamically with the rails, rail fasteners, ballast, and foundation materials. Substitution of ties that have different structural qualities affects the system dynamics. Substitution of materials without adequate detailed design and system testing could result in system failures that could cause derailments and fatal accidents.

Costs of alternate materials can be evaluated on a simple item to item basis, but without consideration of system impacts, the result will be misleading. For example, concrete ties may be only slightly more expensive that treated wood ties. However, they cannot be inserted into track with existing wood ties. The only way that concrete ties can be installed is to rebuild a significant length of track and replace all the wood ties in that stretch with concrete ties. This would most likely occur as an overall rail bed design change, including the entire rail bed section re-design as opposed to a material substitution of ties only.

In this paper, the cost of wood ties will be compared to concrete, steel, and plastic ties. Factors such as transportation cost, tie spacing, and installation costs are addressed. However, the true economic impacts are only partially reflected by this simple calculation. Indirect costs, such as rail wear and train fuel efficiency, which are affected by the tie selection and track design may be significant, but are beyond the scope of this analysis.

Using the routine maintenance tie replacement rate ties provided by the RTA, above, it is estimated that nearly one million ties per year will be replaced in California. This estimate compares favorably with the total California railroads market estimate of 1.5 million equivalent ties, since the replacement rate only addresses routine maintenance replacement and does not include government owned or industrial tracks, new or major reconstruction projects, or other wood uses by the railroad market, such as retaining walls and bridges. Thus, the market estimate equivalent to about 1.5 million ties per year will be used for the following analysis.

6.3. Alternate Materials

Currently, the only accepted, proven alternative to wood ties is concrete ties. Concrete ties are currently accepted for use in only about 6 to 7 percent of rails for high density, high tonnage, high curvature situations. Steel ties are used in some unique applications, but have maintenance issues that limit their use. Plastic and composite ties are being introduced and tested, but do not have a proven record of long term reliability nor have they been demonstrated to perform as stand-alone products where they are not supported by wood ties in the surrounding area.

6.4. Cost of Alternate Materials

If California bans the installation of new treated wood, the economic impact to the railroads will be immense because regular planned track maintenance in which damaged or worn ties are replaced as needed with in-kind ties will not be allowed. When faced with the need to replace a limited number of creosote treated ties, the railroad will be forced into a lose-lose choice of risking track safety by installing dissimilar tie materials, which they will not do, or the high cost of replacing all their track and all ties.

The costs of purchasing and installing treated wood, concrete, steel, and plastic ties are estimated in Table 5. Note that the estimated costs per installed tie provided by the California Railroads are higher, reflecting additional associated costs that are not addressed in Table 5. This comparison of alternate material ties would only apply to a situation where a stretch of track is being rebuilt and all ties are being replaced. As noted above, wood and concrete ties cannot be intermixed. It has not yet been proven whether plastic ties may be acceptable for insertions between existing wood ties in limited application. The costs of steel and plastic ties are significantly more than for concrete. If treated wood ties were no longer allowed, then the railroads would have to transition to concrete ties for all applications since the long term effectiveness of plastic, steel, or composite materials as a maintenance product or as a stand-alone product not supported by wood ties has yet to be proven. For these reasons, concrete will be the only alternate material considered further in this economic analysis.

The transition to concrete tie rail systems would have a huge economic impact on the California railway companies. Rather than ongoing systematic maintenance, the railroads would be forced into major system rebuilds that would otherwise be unnecessary. In addition to the new ties, costs would also include upgrades or replacement of ballast since concrete tie systems require more ballast than with wood ties, upgrade to continuously welded rails, loss of track time and associated revenue, and acquisition of additional rights-of-way for critical sections to minimize down time. The RTA reports that the typical cost of building new track is about $600,000 per mile on owned rights-of-way with prepared sub-grade to about $1,000,000 per mile for a complete new line. That would create a seven to twelve billion dollar problem for railroads to solve in California. Even if some of the materials currently used in wood tie track could be salvaged (e.g., ballast) this minimal salvage value would make virtually no dent in the cost of replacing the entire rail infrastructure in California.

As shown in Table 5 for the installed tie costs for the new-to-new comparison, construction using concrete ties would be about 30 percent more than using wood ties. At this rate, costs would increase by about $45 million per year for the ties alone. However, the more appropriate comparison is **new** concrete tie systems to **maintenance** of existing wood tie rail systems. Typical annual maintenance costs for existing rail systems are estimated to be about $11,800 per mile, based on 2.5 percent annual tie replacement rate and two times the per mile cost estimated in Table 5 to account for extra costs related to partial tie replacement versus continuous. Thus, current railroad spending on rail lines maintenance is estimated to be about $141 million annually.

Assuming the rebuilding could be phased in over 10 years, about $720 million to $1.2 billion annual investment for the next 10 years would be required, or an added cost of about 5 to 9 times more than the current annual maintenance expenditures.

Thus, California railroads would be forced into a massive reconstruction effort while also continuing to maintain most existing track. The combined cost **increase** would be in the range of $760 million to $1.2 billion per year to California railways.

7. MARINE CONSTRUCTION

7.1. Market Description

Treated wood sales into the aquatic market are estimated to be about 1.8 million cubic feet or about 21.7 million board feet amounting to about 4% of the California treated wood market. The products include pilings, timbers, and lumber used to construct and maintain harbor and marina structures, personal use docks, shoreline retaining walls, and other structures in or over ocean and fresh water bodies.

7.2. Evaluation

Costs are evaluated on a project basis. For the treated wood cost, the project cost is divided by the amount of marine use treated wood involved in the project to determine the unit cost per cubic foot. Project costs for alternate materials are totaled. The ratio of alternate material project costs to treated wood project costs is calculated. In this study, 2 case studies are considered. Average treated wood project unit costs and ratios are determined. These averages are then applied to the California marine use treated wood volume to calculate the value of marine treated wood projects in California and the cost that would occur if the same projects were completed using alternative materials instead of treated wood.

The first case study is Genoa's on the Bay (WWPI, 1998). This project involved the installation of pilings and a deck to support a restaurant addition. This project was first designed and bid for steel and concrete and later redesigned and bid for treated wood in order to lower costs. The second case study is the Seattle Port Authority, Terminal 91, Pier 90 project (Personal Communication, 2003). This involved construction of over 410 feet of fender system including pilings and whalers for heavy-duty use. This project was first bid for use of treated wood, but then revised and rebid for use of steel due to regulatory issues. Thus, each case study offers good quality data for both use of treated wood and alternative materials for equal uses.

7.3. Alternate Materials

Most treated wood pilings are treated with creosote, CCA, or ACZA. Alternatives to treated wood piling include galvanized or coated steel, concrete, and plastic. The conventional alternatives to treated wood in marine use are reinforced concrete and steel. Plastic has recently become available for some marine construction uses, but is more expensive than concrete or steel. Thus, further evaluation of plastic is not warranted.

7.4. Cost of Alternate Materials

In Table 6, the cost analysis of the two case studies is performed and California costs for treated wood and alternative material marine projects are estimated. The two case studies are quite different and result in significant unit cost differences. Case 1 is light duty and costs are relatively low. Case 2 is heavy duty for an industrial type shipping facility and, accordingly, unit costs are significantly higher. These represent the typical range of marine construction. For the statewide cost and impact projections, the results of the two cases are averaged.

The estimates indicate that the marine market represents about $25 million in sales of treated wood and with a total installed cost of about $140 million. On average, installed costs for alternative materials will be about two times this amount or about $273 million. The increase in marine construction costs to California to use alternatives to treated wood will be about $134 million per year.

8. ROADS AND HIGHWAYS

8.1. Market Description

Federal and State transportation departments, counties, and cities represent the end users and owners of treated wood in the roads and highways market. Little data is available about the size of this market, so industry statistics (Mickelwright 1998) and judgement were used to estimate the market as shown in Table 7. Treated wood products include posts, guardrail supports, crossing planks and panels at railroad crossings, highway bridge timbers, and fence posts for rights-of-way fencing. Approximately 406,000 cubic feet or 5 million board feet are used each year representing about 1% of the California treated wood market.

8.2. Evaluation

Treated wood products used in the transportation market vary considerably. However, the products are similar to those in other markets previously evaluated in this paper. Lumber used in signs is similar to lumber for decking, heavy-duty supports may be similar to poles or marine construction and bridge timbers and highway guard-rail posts are similar to marine construction. Thus, the market impact considers an average of these cost factors.

8.3. Alternate Materials

Alternatives to treated wood include steel, concrete, and plastic or composite materials, depending on the particular use.

8.4. Cost of Alternate Materials

Based on the range of alternate materials of similar uses, a representative average material cost factor of two times the cost of treated wood is estimated. As shown in Table 7, the increased cost to California for alternate products for use in roads and highways is about $6 million per year.

9. OTHER MARKETS

As noted previously, the markets evaluated total approximately 90 percent of the total. Without trying to determine what these other market uses of treated wood are, the costs of the other uses are addressed in Table 8. The weighted average unit material cost is calculated from the other main market areas and is assumed applicable to the Other markets. Similarly, the costs of other materials have typically been found to be about two times more than for treated wood. The estimated cost of alternate materials and total cost to California are calculated in this way.

The annual sales of treated wood in California for the Other market areas is estimated to be about $57 million. Use of alternate materials increases this cost by about $57 million to a total cost of about $113 million per year.

10.CONCLUSION

California represents approximately seven percent of the U.S. market for preservative treated wood. Sales of treated wood in California currently amounts to nearly 40 million cubic feet each year. Treated wood use represents an investment of about $1.0 billion annually in California. Treated wood customers, including homeowners, government agencies at all levels, utility and railroad companies, marina and dock owners, and contractors have consistently chosen treated wood over other available products due to cost, performance, and aesthetic reasons.

Costs to the separate market areas in California are summarized and totaled in Table 9. The cost of installing treated wood products in California is estimated to be about $1.0 billion per year. This cost would increase to about $3.4 billion per year for alternate products for a net increase in costs to California of about $2.4 billion ($2,400,000,000) annually. Increased costs would impact wide segments of the California economy, including the following:

- Residential and commercial construction increase of about $1.1 billion per year.
- Utilities pole costs increased by about $100 million.
- Railroads would be forced to replace existing systems at a cost of about $960 million per year for the next 10 years while also increasing tie replacement costs about $45 million per year.
- Marine construction cost would increase by about $130 million.
- Road and highway transportation agencies costs would increase by $6 million annually.

If legislation or regulations are passed in California prohibiting the use of treated wood products the cost implications for California will be significant. Alternatives to treated wood, such as steel, plastic, concrete, or composites generally cost 1.5 to 3 times (50 to 200 percent) more than treated wood.

Indirect impacts and costs, not quantified in this paper, would potentially be even more significant than the direct costs. Potential indirect impacts include increased accidents and injuries, loss of utility service, railroad derailments, increased emissions of greenhouse gases, and reduced efficiency of workers.

Although alternatives to treated wood products have been widely available for many years, treated wood has been the material of choice for many structures subject to decay and weathering. It has been chosen because it provides a reliable, cost effective, aesthetically pleasing final product. Selection of preservative-treated wood is an environmentally responsible decision because wood requires less energy, results in lower emissions, and, unlike the alternatives, is grown and manufactured in the United States. Prohibiting the installation of treated wood would result in less acceptable, more expensive construction and infrastructure investment in California.

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TABLE 1
CALIFORNIA TREATED WOOD MARKET ANALYSIS

Annual Sales of Treated Wood in California[1]

Waterborne	34,541	1,000 cubic feet
Oil Borne	2,514	1,000 cubic feet
Creosote	6,473	1,000 cubic feet
All Treated Wood	43,528	1,000 cubic feet

Residential and Commercial Market

Product (Waterborne Preservative Only)	U. S. Volume[2]		California Volume	Estimated Residential and Commercial Outdoor Market		
	(1000 cf)	(percent)	(1000 cf)	(percent)	(1000 cf/yr)	(1000 bf/yr)
Fence Posts	8,996	2.42%	835	50.00%	418	7,098
Lumber	245,691	66.03%	22,808	90.00%	20,527	348,961
Timbers	54,084	14.54%	5,021	80.00%	4,017	68,282
Specialty Products	12,104	3.25%	1,124	50.00%	562	9,551
Landscape Timbers	13,262	3.56%	1,231	90.00%	1,108	18,836
Other Products	5,782	1.55%	537	50.00%	268	4,562
All Products	372,082	91%	31,555		26,899	457,291
Percent of CA Waterborne Market				85.25%		
Percent of CA Treated Wood Market				61.80%		

Utilities Market

Product (All Preservatives)	U. S. Volume[2]		California Volume	Estimated Utilities Market		
	(1000 cf)	(percent)	(1000 cf)	(percent)	(1000 cf/yr)	(1000 bf/yr)
Poles	48,417	10.03%	4,365	100.00%	4,365	52,383
Cross Arms	2,014	0.42%	182	100.00%	182	2,179
All Products	482,789		4,547		4,547	54,562
Percent of CA Treated Wood Market				10.45%		

Railroad Market

Product (All Preservatives)	U. S. Volume[2]		California Volume	Estimated Railroad Market		
	(1000 cf)	(percent)	(1000 cf)	(percent)	(1000 cf/yr)	(1000 bf/yr)
Cross Ties	55,611	11.52%	5,014	100.00%	5,014	60,166
Switch & Bridge Ties	4,382	0.91%	395	100.00%	395	4,741
Timber	55,191	11.43%	4,976	5.00%	249	2,986
All Products	482,789		10,385		5,658	67,893
Percent of CA Treated Wood Market				13.00%		

TABLE 1
CALIFORNIA TREATED WOOD MARKET ANALYSIS

Marine Construction Market

Product (All Preservatives)	U. S. Volume[2]		California Volume	Estimated Marine Construction Market		
	(1000 cf)	(percent)	(1000 cf)	(percent)	(1000 cf/yr)	(1000 bf/yr)
Piling	5,898	1.22%	532	80.00%	425	5,105
Lumber	251,381	52.07%	22,664	5.00%	1,133	13,599
Timber	55,191	11.43%	4,976	5.00%	249	2,986
All Products	482,789		28,172		1,807	21,689
Percent of CA Treated Wood Market				4.15%		

Roads and Highways Market

Product (All Preservatives)	U. S. Volume		California Volume	Estimated Roads and Highways Market		
	(1000 cf)	(percent)	(1000 cf)	(percent)	(1000 cf/yr)	(1000 bf/yr)
Posts, guardrails, and crossing planks and panels[3]		0.28%	122	100.00%	122	1,463
Timber	55,191	11.43%	4,976	5.00%	249	2,986
Fence Posts[2]	9,817	2.03%	702	5.00%	35	597
All Products	482,789				406	5,045
Percent of CA Treated Wood Market				0.93%		

California Markets Summary

Market Area Description	(percent)	(1000 cf/yr)	(1000 bf/yr)
Residential and Commercial	61.80%	26,899	457,291
Utilities	10.45%	4,547	54,562
Railroads	13.00%	5,658	67,893
Marine Construction	4.15%	1,807	21,689
Roads and Highways	0.93%	406	5,045
Other	9.67%	4,211	71,583
Total	100.00%	43,528	739,976

Notes:
(1) Smith, March 2003
(2) Micklewright, August 1998 (Table 5, Production by Reporting Plants)
(3) Smith, March 2003 (Table 5-1, California Treated Wood User Cost Increases)

TABLE 2
CONSTANTS AND CONVERSION FACTORS

Wood Density	26	lb/cf	26	lb/cf
	0.351	ton/cy	26000	lb/1000cf

Conversions between nominal measure and net (actual) measure
Production statistics for lumber are based on actual lumber measure.
Volume reported as cubic feet (cf) (12"x12"x12") or board feet (bf) (12"x12"x1")

1.0 cf (nominal)	=	12 bf (nom)	
1.0 cf (actual)	=	17 bf (nom)	Use for water borne
1.0 cf (actual)	=	12 bf (actual)	Use for creosote and oil borne

Conversion to board feet	Nominal/Actual		Area	Fraction	Fraction	Factor
Typical lumber dimensions	Width (inch)	Thickness (Inch)	(square inch)	(actual to nominal)	nominal to actual	bf per actual cf
1 x 6 board (actual)	5.50	0.63	3.44	57.29%		
1 x 6 board (nominal)	6.00	1.00	6.00		174.55%	20.94545
2 x 4 board (actual)	3.50	1.63	5.69	71.09%		
2 x 4 board (nominal)	4.00	2.00	8.00		140.66%	16.87912
2 x 8 board (actual)	7.50	1.63	12.19	76.17%		
2 x 8 board (nominal)	8.00	2.00	16.00		131.28%	15.75385
Average Ratio (bf as % of cf)				68.19%	148.83%	17.86
Conversion factor to use (nominal board foot per actual cubic foot)						**17**

Railroad Tie Conversion	(inch)	(inch)	(feet)	(c.f./tie)
Standard Dimensions	7	9	8.5	**3.72**

TABLE 3
RESIDENTIAL AND COMMERCIAL MARKET

Residential and Commercial Treated Wood Sales	43,528,000	c.f./yr
Typical Treated Wood Project Unit Cost	$13.00	/c.f.
Value of Res. and Com. Treated Wood Projects	$565,864,000	/yr
Typical Ratio of Alternate to Treated Wood Materials	3	
Cost of Same Projects Using Alternate Materials	$1,697,592,000	/yr
Increased Cost to CA for Alternate Materials	$1,131,728,000	/yr

RESIDENTIAL DECK

Size	15	feet by	30	feet	450	square feet

		Volume	Treated Wood				Plastic Lumber			
Component	Nom. Size	Factor	Spacing	Quantity	Unit Cost	Amount	Spacing	Quantity	Unit Cost	Amount
	(inch)	(b.f /l.f.)	(feet)	(lin. feet)	($/lin.ft.)		(feet)	(lin. feet)	($/lin.ft.)	
Beams	2ea-2 x 12	4.00	10	60	$1.75	$104.96	10	60	8.45	$507.00
Joists	2 x 6	1.00	2	240	$0.87	$209.85	1	465	4.01	$1,864.65
Deck Boards	2 x 6	1.00	0.48	938	$0.87	$819.73	0.48	938	1.99	$1,865.63
Rail Posts	4 x 4	1.33	4	96	$1.16	$111.48	4	96	7.3	$700.80
Railing Boards	2 x 6	1.00		120	$0.87	$104.93		120	4.01	$481.20
Railing Cap Board	2 x 8	1.33		60	$1.25	$74.96		60	5.39	$323.40
Total Cost						$1,425.91				$5,742.68
Unit Cost ($/s.f.)						$3.17				$12.76

Total Quantity of Lumber (b.f.)	1745.5
Average Unit Cost ($/b.f.)	$0.82
Average Unit Cost ($/c.f.)	$13.89

		TREX (Composite) Lumber			
Component	Nom. Size	Spacing	Quantity	Unit Cost	Amount
	(inch)	(feet)	(lin. feet)	($/lin.ft.)	
Beams	2ea-2 x 12	10	60	8.45	$507.00
Joists	2 x 6	2	240	4.01	$962.40
Deck Boards	2 x 6	0.48	938	1.749375	$1,640.04
Rail Posts	4 x 4	4	96	5.811628	$557.92
Railing Boards	2 x 6		120	1.749375	$209.93
Railing Cap Board	2 x 8		60	1.749375	$104.96
Total Cost					$3,982.24
Unit Cost ($/s.f.)					$8.85
		Ratio to Treated Wood:			2.79

Note: Structural plastic lumber used for beams and joists.

Concrete Slab Construction

Description	Unit Cost ($/s.f.)	Ratio to Treated Wood
Slab on grade, 4" thick		
Broom finish	$2.95	0.93
Exposed aggregate (low)	$3.57	1.13
Exposed aggregate (high)	$5.42	1.71

Note: Unit costs per Means 2002.

TABLE 3
RESIDENTIAL AND COMMERCIAL MARKET

FENCING

Base on Fence Boards of Nominal 1"x6"-6' size

Material Type	Price		Ratio to Treated	Price Source
Treated Wood	$1.80	ea.		Phone Quote-All Weather Wood
Cedar	$2.49	ea.	1.38	Phone Quotes
Redwood	$2.49	ea.	1.38	Phone Quotes
Plastic Lumber	$8.34	ea.	4.63	Internet epsplasticlumber.com
Polywood Lumber	$8.25	ea.	4.58	Internet governmentsales.com
Ratio to Treated Wood (Ave)			3.00	

TABLE 4
CALIFORNIA UTILITIES MARKET

California Pole Market

Pole Sales in CA	4,365,251	cf/yr
Average Pole Size	C4-45'	
Cubic Feet per pole	25.6	cf/pole
Poles Purchased	170,518	poles/yr
Unit Price of Treated Wood Pole	$450	each
Value of Treated Wood Pole Sales	$76,732,928	/yr
Unit Installed Cost of Treated Wood Pole	$800	each
Installed Cost of Treated Wood Poles	$136,414,094	/yr
Ratio of Installed Cost Alt. to Wood	1.71	
Installed Cost of Alternate Materials	$233,609,137	/yr
Increased Cost to Utilities for Alt. Materials	$97,195,042	/yr

Treated Wood Pole Spending

Average Cost	$450	/pole	$17.58	/c.f.

Alternate Pole Materials Comparison

Description	Units	Treated Wood	Fiber-glass	Steel	Concrete
New and replacement poles	$/pole	$450	$1,000	$500	$500
Freight	$/pole	$50	$50	$120	$200
Installation	$/pole	$300	$300	$300	$600
Pole steps	$/pole	$0	$150	$150	$150
Steps Installation	$/pole	$0	$150	$150	$150
Raptor protection	$/pole	$0	$0	$150	$150
Installed Total Cost (Each)	$/pole	$800	$1,650	$1,370	$1,750
Ratio of Alternate to Treated Wood Installed Cost			2.06	1.71	2.19

TABLE 5
CALIFORNIA RAILROADS TREATED WOOD MARKET

Railroad Sales in CA	5,657,737	c.f./yr	1,521,408 equivalent ties
Treated Wood Railroads Use Average Unit Price	$7.53	/c.f.	
CA Railroads Use Treated Wood Sales	$42,599,429	/yr	
CA Average Unit Treated Wood Installed Cost	$19.50	/c.f.	
CA Treated Wood Installed Cost	$110,302,092	/yr	
Average Installed Cost Ratio of Alternates to Treated Wood	1.41		
CA Cost of Using Alternates	$155,367,152	/yr	
Increased Cost to CA Railroads for Alternate Materials	$45,065,061	/yr	

ESTIMATED INSTALLED COSTS OF RAILWAY TIES IN NEW TRACK SYSTEM

	Creosote Treated Wood			Concrete			Plastic/Steel		
System Component	Factors		Costs	Factors		Costs	Factors		Costs
Cross Tie			$28.00			$41.00			$65.00
Size	7"x9"x8'6"			11"x9"x8'6"			7"x9"x8'6"		
Spacing	19.5	inch		24	inch		19.5	inch	
Weight	200	pounds		700	pounds		217	pounds	
Hardware (New)			$13.50			$12.00			$13.50
Ties per mile of track	3,249	ties		2,640	ties		3,249	ties	
Labor and Equipment to Install									
Installation Cost per tie			$30.00			$60.00			$30.00
Transportation to Job			$1.00			$3.50			$1.09
Assume distance is	400	mile		Same as wood			Same as wood		
Car load is	80,000	pounds		Same as wood			Same as wood		
Car load of ties	400	ties		114	ties		369		
Cost per loaded car-mile	$1.00			Same as wood			Same as wood		
INSTALLED COST PER TIE w/new hardware			$72.50			$116.50			$109.59
INSTALLED COST PER MILE			$235,569			$307,560			$356,067
Ratio Alternate to Treated Wood Cost						1.31			1.51

Ratio of Alternate to Treated Wood	1.31	
Unit Treated Wood Tie Material Cost	$7.53	/c.f.
Unit Treated Wood Tie Installed Cost	$19.50	/c.f.

EVALUATION OF REPLACEMENT TO MAINTENANCE OF EXISTING COSTS

Description		High Range		Low Range	
Existing Railway in California		12,000	miles	12,000	miles
Average maintenance cost (2x $/mile and 2.5%/yr)		$11,778.46	/yr/mile	$11,778.46	/yr/mile
Annual railways maintenance		$141,341,538	/yr	$141,341,538	/yr
Cost to replace existing railways		$1,000,000	/mile	$600,000	/mile
CA cost of new railways		$12,000,000,000		$7,200,000,000	
Replacement cost spread over	10 years	$1,200,000,000	/yr	$720,000,000	/yr
Ratio of replacement to maintenance annual cost		8.49		5.09	
Mid-Range Replacement Cost Estimate		$960,000,000	/yr		

TABLE 6
CALIFORNIA MARINE TREATED WOOD MARKET

Marine Sales in CA	1,807,427	c.f./yr
Treated Wood Marine Use Average Unit Price	$13.57	/c.f.
CA Marine Use Treated Wood Sales	$24,522,731	/yr
CA Average Unit Treated Wood Project Cost	$77.34	/c.f.
CA Treated Wood Projects Cost	$139,786,680	/yr
erage Installed Cost Ratio of Alternates to Treated Wood	1.96	
CA Cost of Projects Using Alternates	$273,426,610	/yr
Increased Cost to CA for Alternate Materials	$133,639,931	/yr

Case Study-Genoa's On the Bay

Treated Wood	Diam.	Length	Quantity	Unit Cost	Amount	Cubic Feet
	(inch)	(feet)				
Piling	12	55	7	$577.50	$4,042.50	302
Piling	16	60	12	$630.00	$7,560.00	1,005
Installation			19	650	$12,350.00	
Total Cost					$23,952.50	1,308
Unit Cost of Material ($/c.f.)					$8.87	
Unit Cost of Installation ($/c.f.)					$9.44	
Unit Cost Installed ($/c.f.)					$18.32	

Steel/Concrete	Diam.	Length	Quantity	Amount
	(inch)	(feet)		
Piling	12	55	7	$37,350.00
Piling	16	60	12	$18,500.00
Installation			19	Included
Total Cost				$55,850.00

Ratio Installed Cost Steel/Concrete to Treated Wood:	2.33

Case Study-Terminal 91, Pier 90, Port of Seattle

Project includes 410 L.F. of wharf fender system that was first bid for treated wood and then changed to steel. Information from Manson Construction.

Material	Quantity		Conversion		Quantity	
Piling ('9"tip/16"butt)	42	piles	70	c.f./pile	2,940	c.f.
Timber	14000	b.f.	12	b.f./c.f.	1,167	c.f.
Total Treated Wood Used					4,107	c.f.
Treated Wood Material Cost					$75,000	
Installed Cost based on Treated Wood					$560,000	
Unit material cost of treated wood					$18.26	/c.f.
Unit treated wood installed cost					$136.36	/c.f.
Revised cost using steel instead of treated wood					$885,000	
Ratio Installed Cost Steel to Treated Wood					1.58	

TABLE 7
ROADS AND HIGHWAYS MARKET

Roads and Highways Treated Wood Sales	405,796	c.f.
Unit Treated Wood Sales Price	$15.01	/c.f.
Value of Roads and Highway T.W. Sales	$6,091,434	/yr
Ratio of Alternate Materials to Treated Wood	2	
Cost of Alternative Materials for Road/Hwy Use	$12,182,868	/yr
Increased Cost to Road/Hwy Market	$6,091,434	/yr

Comparison to Markets of Similar Use

Similar Use Markets	Unit Material Cost	Ratio
Residential Deck	$13.89 /c.f.	3
Treated Wood Pole	$17.58 /c.f.	1
Marine Construction	$13.57 /c.f.	1.96
Average	$15.01 /c.f.	1.99

TABLE 8
OTHER MARKETS

Other Markets Treated Wood Sales	4,210,751	c.f.
Unit Treated Wood Sales Price	$13.38	/c.f.
Value of Other Treated Wood Sales	$56,337,094	
Ratio of Alternate Materials to Treated Wood	2	
Cost of Alternative Materials for Other Use	$112,674,188	
Increased Cost to Other Markets	$56,337,094	

Market Price Analysis

Basis: Assume weighted average of other main market areas for unit material price and assume reasonable average cost increase factor of 2.

Market Area Description	(percent)	Unit Material Cost	Products
Residential and Commercial	61.80%	$13.89 /c.f.	8.58
Utilities	10.45%	$17.58 /c.f.	1.84
Railroads	13.00%	$7.53 /c.f.	0.98
Marine Construction	4.15%	$13.57 /c.f.	0.56
Totals	89.39%		11.96
Weighted Average		**$13.38 /c.f.**	

TABLE 9
SUMMARY OF COSTS BY MARKET

	Treated Wood		Alternate Materials	
Market Area Description	Sales	Installed Cost	Installed Cost	Increased Cost
	($/yr)	($/yr)	($/yr)	($/yr)
Residential and Commercial	$565,864,000	$565,864,000	$1,697,592,000	$1,131,728,000
Utilities	$76,732,928	$136,414,094	$233,609,137	$97,195,042
Railroads	$42,599,429	$110,302,092	$155,367,152	$45,065,061
Railroads System Replacement		$0	$960,000,000	$960,000,000
Marine Construction	$24,522,731	$139,786,680	$273,426,610	$133,639,931
Roads and Highways	$6,091,434	$6,091,434	$12,182,868	$6,091,434
Other	$56,337,094	$56,337,094	$112,674,188	$56,337,094
Total	$772,147,616	$1,014,795,394	$3,444,851,955	$2,430,056,561

Note: Change in installation/labor cost assumed not significant for Res/Com Outdoor, Road/Hwy and Other Markets