Conclusions and Summary Report on an Environmental Life Cycle Assessment of Borate-Treated Lumber Structural Framing with Comparisons to Galvanized Steel Framing

ISO 14044 Compliant

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Conclusions and Summary Report

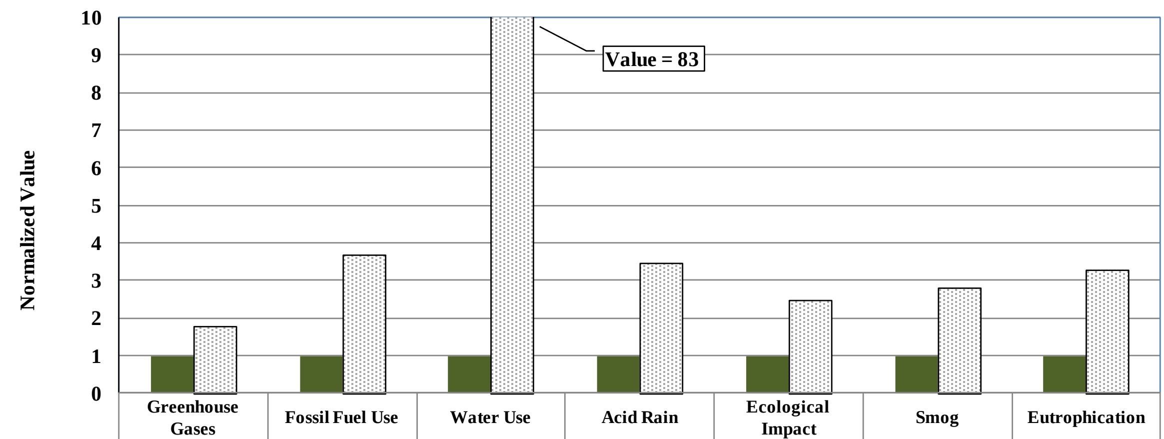
1. Conclusions & Executive Summary

The Treated Wood Council has completed a quantitative evaluation of the environmental impacts associated with the national production, use, and disposition of borate (disodium octaborate tetrahydrate)-treated lumber structural framing and galvanized steel framing using life cycle assessment (LCA) methodologies and following ISO 14044 standards. The results for treated wood framing are significant.

- **<u>Less Energy & Resource Use</u>:** Treated wood framing requires less total energy, less fossil fuel, and less water than galvanized steel framing.

- **<u>Lower Environmental Impacts</u>:** Treated wood framing has lower environmental impacts in comparison to galvanized steel framing in all five of the impact indicator categories assessed: anthropogenic greenhouse gas, acid rain, smog potential, ecotoxicity, and eutrophication-causing emissions.
- **<u>Less Fossil Fuel Use</u>:** The fossil fuel footprint of 100 linear feet of treated lumber structural wall framing is equivalent to driving a car 540 miles. In comparison, the fossil fuel footprint of 100 linear feet of galvanized steel structural wall framing is equivalent to driving a car 2,000 miles.
- **<u>Recoverable Energy</u>:** The carbon embodied in wood makes out-of-service wood products excellent candidates for energy recovery. Treated wood can be used in appropriately permitted cogeneration facilities or synthetic fuel manufacturing facilities as a renewable fuel source.

Figure 1 Impact indicator comparison (normalized to borate-treated lumber = 1.0)



	Greenhouse Gases	Fossil Fuel Use	Water Use	Acid Rain	Ecological Impact	Smog	Eutrophication
Borate Lumber	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Galv. Steel Framing	1.8	3.7	83	3.5	2.5	2.8	3.3

Impact indicator values for the cradle-to-grave life cycle of borate-treated lumber were normalized to one (1.0), with galvanized steel framing impact indicator values being a multiple of one (if larger) or a fraction of one (if smaller). The normalized results are provided in Figure 1.

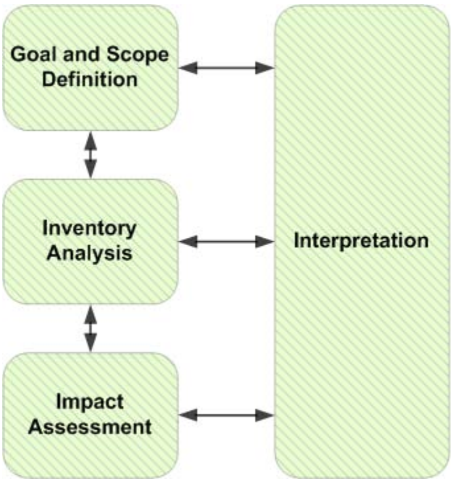
2. Goal and Scope

The goal of this study is to provide a comprehensive, scientifically-based, fair, and accurate understanding of environmental burdens associated with the manufacture, use, and disposition of structural framing materials using LCA methodologies. The scope of this study includes:

- Life cycle inventories of borate-treated lumber and galvanized steel framing. Borate was chosen as a representative preservative for assessment of treated wood framing.
- Calculation and comparison of life cycle impact assessment indicators: anthropogenic greenhouse gas, acid rain, smog, ecotoxicity, and waterborne eutrophication impacts potentially resulting from life cycle air emissions.
- Calculation of energy, fossil fuel, and water use.

3. Quality criteria

This LCA study was done in accordance with the principles and guidance provided by the International Organization for Standardization (ISO) in standards ISO/DIS 14040 and ISO/DIS 14044. The LCA procedures and findings were evaluated by a panel of external reviewers in accordance with Section 6 of ISO 14044. The external reviewers confirmed that the LCA followed the ISO standards and that the comparative assertions were done using equivalent functional units and equivalent methodological considerations.



4. Manufacturer Information

This assessment addresses two structural framing products.

- The LCA for borate-treated lumber includes weighted averages of survey responses representing 29% of the total U.S. borate-treated lumber market.
- The LCA for galvanized steel framing represents a general product category, manufactured by different producers. The LCA provides a basis for general comparison of products.

5. Product Description and Functional Unit

The products of focus in this LCA are (1) borate-treated Pacific Northwest species two-inch nominal thickness lumber, treated for interior construction that is protected from weather but may be subject to dampness and does not contact ground (AWPA Use Category 2), according to the AWPA standards, and (2) a galvanized steel framing product that represents the general product category.

Scope: Cradle-to-grave

Functional unit: 100 linear feet of structural perimeter framing using 2 x 6 inch materials and standard wall construction.

System boundary: from the extraction of the raw materials through processing, transport, primary service life, and disposition of the product.

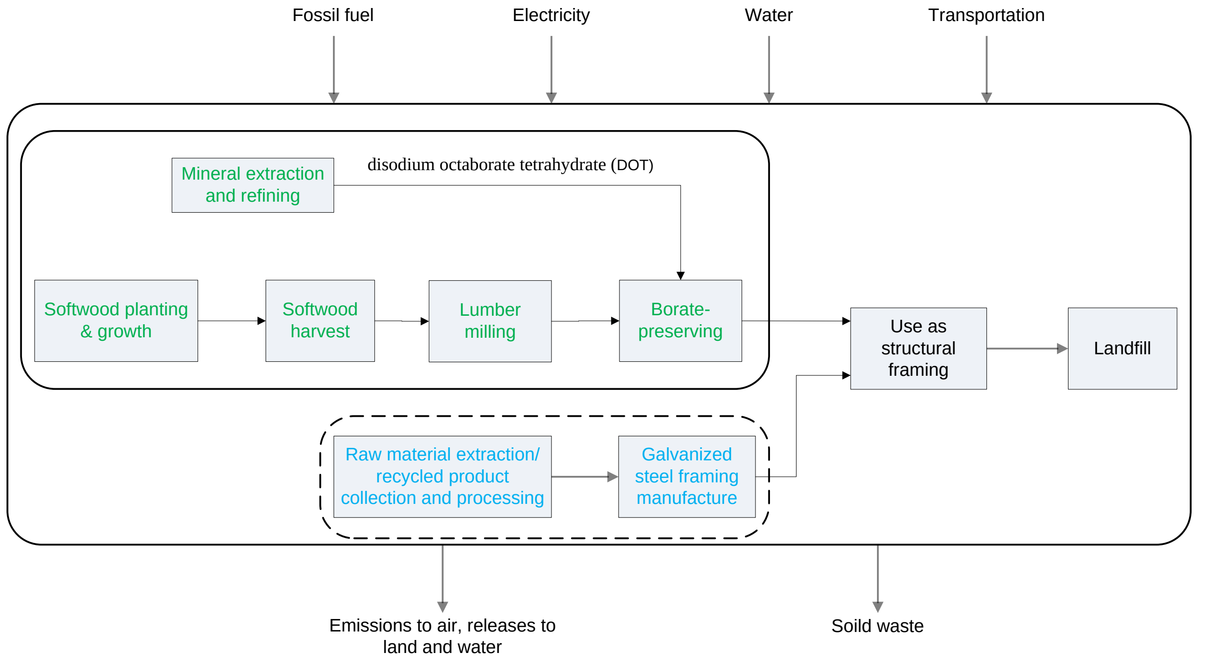
Geographic boundary: U.S.

6. Life Cycle Inventory

The inventory analysis phase of the LCA involves the collection and analysis of data for the cradle-to-grave life cycle of the structural framing materials. For each stage of the product life cycle, inputs of energy and raw materials, outputs of products, co-products and waste, and environmental releases to air, water, and soil are determined.

The system boundaries include all the production steps from extraction of raw materials from the earth and manufacture of the framing product (cradle-to-gate) to use of the product and final disposition after its service life (gate-to-grave). Figure 2 illustrates the system boundaries and process flow for both borate-treated lumber and galvanized steel framing as assessed in this study.

Figure 2 System boundary and process flow for structural framing (Cradle-to-gate processes for borate-treated are shown in green and galvanized steel are shown in blue. Gate-to-grave processes are shown as the same.)



Borate-treated lumber and galvanized steel framing are compared, based on 100 linear feet of 2 x 6 structural perimeter residential wall framing. LCI inputs and outputs are not sensitive to the length of time that framing remains in service since both framing products are expected to have comparable service lives.

7. Environmental Performance

The assessment phase of the LCA uses the inventory results to calculate total energy use, impact indicators of interest, and resource use. For environmental indicators, USEPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) is used to assess anthropogenic greenhouse gas, acid rain, smog potential, ecotoxicity, and eutrophication impacts potentially resulting from air emissions. The categorized energy use, resource use, and impact indicators provide general, but quantifiable, indications of environmental performance. The results of this impact assessment are used for comparison of borate-treated lumber and galvanized steel framing as shown in Table 1.

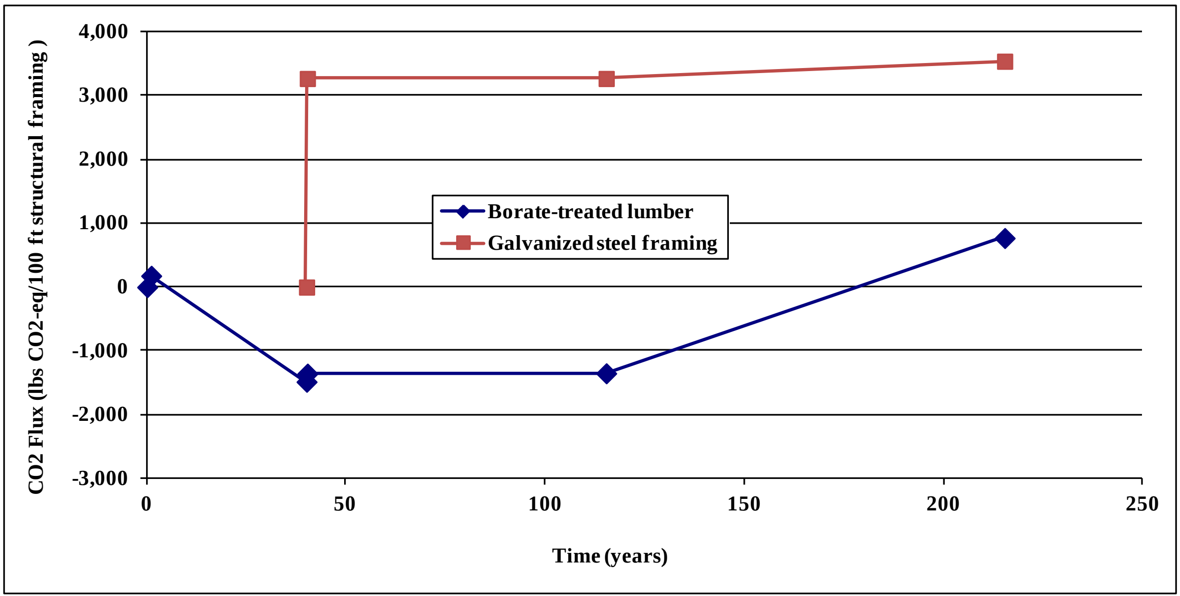
Table 1 Environmental performance (per 100 feet of structural perimeter home framing)

Impact category	Units	Borate-treated lumber framing	Galvanized steel framing
Energy use			
Energy input from technosphere	MMBTU	1.8	1.4
Energy input from nature	MMBTU	1.9	12
Biomass energy	MMBTU	0.036	0.029
Impact indicators			
GHG emissions	lb-CO_2-eq	2,000	3,500
Acid rain potential	lb-H+ mole-eq	240	830
Smog potential	g NOx / m	1.3	3.6
Air emission ecotoxicity	lb-2,4-D-eq	1.9	4.8
Eutrophication	lb-N-eq	0.073	0.24
Resource use			
Fossil fuel use	MMBTU	3.3	12
Water use	gal	83	6,900

The carbon balance of borate-treated lumber and galvanized steel framing, through the life cycle stages, is shown in Figure 3. For wood products, the carbon balance begin at zero, rises due to greenhouse, fertilizer, and transport requirements for seedlings, then drops well below zero as the trees grow (as carbon is removed from the atmosphere as carbon dioxide) during approximately 40 years. Carbon emissions resume at harvest because of transportation and milling. Carbon emissions continue to rise because of preservative manufacture and treatment. Carbon emissions do not result from the use stage, but a final increase occurs as the wood decays in landfills with most of the increase related to methane emissions from the landfill.

The galvanized steel product begins its life cycle either as a raw material or with the recycling of steel products. Both processes result in carbon emissions. Burdens associated with recycling transportation, sorting, cleaning, and melting must be included. Carbon emissions do not result from the use stage, but emissions do result from transport to a landfill and landfill construction. For the purposes of this LCA, it was assumed that 40 percent of the demolition steel framing waste is separated and recycled.

Figure 3 Total Carbon (Anthropogenic + Biogenic) Balance (per 100 linear feet of structural framing)



8. Additional Information

This study is further detailed in a Procedures and Findings Report completed November 3, 2009 and is available upon request from the Treated Wood Council at www.treated-wood.org/contactus.html.

This study has been published in the peer reviewed *Journal of Cleaner Production* and is available at http://dx.doi.org/10.1016/j.jclepro.2010.12.004.