Railway Tie Association

Presented by:

James C. Gauntt
Executive Director

Developments in Pressure Treated Wood Crossties
RTA History

- Organized St. Louis, 1919, from timber organizations dating from 1880’s
- Crosstie manufacturers (sawmill, treaters)
- First Annual Meeting: Railroad representatives present
- First Issue: Timber Conservation
- First Committees: Tie and Wood Preservative Standards
- First Preservatives: Creosote & ZnCl
2,840 Company Members
3,579 Individuals within Companies
40 Event Sponsors
Mission: Improve Wood Life Cycle Cost
5 Committees (96 members)
3 Tie Related Specifications:
  Conformance with AREMA Chapter 30
Forum for the exchange of technical information – members and public
**RTA Activities - Programs**

- Can be Grouped Into 5 Key Areas
  1. Education
  2. Market Information Development and Product Research
  3. Membership Maintenance and Growth
  4. Communication
  5. Administration
RTA Activities - Programs

- **Education**
  - Technical Conferences and Seminars
    - Annual Meeting
    - Field Trips
    - Tie Grading Seminars
  - Publications
  - Scholarships
  - Video and CD-ROM based Training Modules
  - Industry Connections
  - Web Site [www.rta.org](http://www.rta.org)
RTA Activities - Programs

- Market Information Development and Product Research
  - Product Development Research Projects
  - Econometrics and Forecasting
  - Online Industry Statistics
  - Tie Production/Inventory-Sales Ratio
  - Interactive Scenario Spreadsheets
  - Custom Work – PPI vs. Historical Pricing Data
RTA Activities - Programs

- Communication
    - Every Railroad, Sawmill, Member and Select Legislators – NOW DIGITAL too
  - Industry Articles and PR
  - AREMA and AWPA Papers - Speeches
  - Legislative Support and Work in DC
    - Railroad Day-on-the-Hill, etc.
  - EPA and State Presentations
    - Creosote Reregistration, Solid Waste Rules, etc.
What’s going on in the world of tie supply and demand?

Usually it is a relatively uneventful marketplace but in 2013 things were wildly different.

A little history shows some remarkable trends.

Current dynamics suggest long road ahead.

Hardwood Lumber Production Available to the US Market from All Sources

Sources: US Census and Hardwood Market Report

Graph: HMR Executive®

*projected
Consumption of Hardwood Lumber by Domestic and Export Grade Markets and Industrial Lumber and Timber Markets

©2013 Hardwood Market Report

*Annualized
Consumption of Hardwood Lumber by Major US Markets and Total Supply of Hardwood Lumber

©2013 Hardwood Market Report
US Exports of Hardwood Lumber to China

1999 - 2006
US Furniture Manufacturing Shift to China and US Housing Boom

2006 - 2009
US Housing Bust and Worldwide Economic Turmoil

China's Growing Middle Class Consuming US Hardwoods

1999 - 2006
+ 759.5%

2009 - 2013
+ 150.7%

Source: USDA FAS
Graph: HMR Executive®
US Housing Starts
with Projections Through 2015

Sources: US Census Bureau and NAHB
Graph: Hardwood Market Report

2010: 587,000 units, + 6.0% over 2009
2011: 609,000 units, + 3.8% over 2010
2012: 781,000 units, + 28.2% over 2011
2013: 955,000 units, + 22.3% over 2012
2014: 1,172,000 units, +22.7% over 2013
2015: 1,492,000 units, +27.7% over 2014

1,502,723 units average (saar since 1963)
2013 was one of the wettest years on record since 1895. 

*The Southeast Regional Climate Center*
Rain has been a problem

2014 Only Slightly Behind Pace of 2013
Since 1995 RTA has Sponsored 40+ Significant Research Projects

Two Current Major Projects

- Economics of Dual Treatments
Introduction

- RTA/MSU and separate MSU studies have shown that dual treatment with creosote + borate and CuNap + borate can lead to a significant extension of wood tie life, particularly in areas where environmental decay is the primary factor in tie failure.

- Slides explain the projected life extension in the US based on dual treatment, and the economic benefit of dual treatment.
Why Dual Treatment?
What is Dual Treatment?

Borate pre-treatment arrested decay even after inoculation.
What is Dual Treatment?

Borate pre-treatment arrested decay even after inoculation.

- Timbor
- Busan
- Creosote
- 2 dips
- White Oak
# Current US Average Class 1 Tie Life

- Based on 5-year history of tie replacements

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track Miles</td>
<td>162,056</td>
<td>161,114</td>
<td>160,734</td>
<td>160,781</td>
<td>160,781</td>
</tr>
<tr>
<td>Ties*</td>
<td>526,557,342</td>
<td>523,496,566</td>
<td>522,261,858</td>
<td>522,414,572</td>
<td>522,414,572</td>
</tr>
<tr>
<td>Wood Ties**</td>
<td>500,229,474</td>
<td>497,321,738</td>
<td>496,148,766</td>
<td>496,293,844</td>
<td>496,293,844</td>
</tr>
<tr>
<td>Ties Installed</td>
<td>14,017,000</td>
<td>13,464,000</td>
<td>14,401,000</td>
<td>14,463,000</td>
<td>14,292,000</td>
</tr>
<tr>
<td>Tie Life (years)</td>
<td>35.7</td>
<td>36.9</td>
<td>34.5</td>
<td>34.3</td>
<td>34.7</td>
</tr>
<tr>
<td>5-year Average of US Tie Life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>35.2</strong></td>
</tr>
</tbody>
</table>

*Based on 3249 ties per mile

**Based on US ties being 95% wood and 5% other materials
Dual-treatment to be used primarily in zones with most severe wood decay (Zones 5, 4, and 3)
# Wood Ties by Climate Zone

- Based on state-by-state totals of Class 1 “route miles” from AAR

<table>
<thead>
<tr>
<th></th>
<th>All US</th>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Zone 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US Route Miles</strong></td>
<td>139,679</td>
<td>27,195</td>
<td>28,702</td>
<td>39,278</td>
<td>30,263</td>
<td>14,241</td>
</tr>
<tr>
<td><strong>Dist. (%)</strong></td>
<td>100%</td>
<td>19.5%</td>
<td>20.5%</td>
<td>28.1%</td>
<td>21.7%</td>
<td>10.2%</td>
</tr>
<tr>
<td><strong>US Track Miles</strong></td>
<td>212,365</td>
<td>41,347</td>
<td>43,638</td>
<td>59,717</td>
<td>46,011</td>
<td>21,652</td>
</tr>
<tr>
<td><strong>Percentage Wood</strong></td>
<td>94.8%</td>
<td>90%</td>
<td>90%</td>
<td>98%</td>
<td>98%</td>
<td>98%</td>
</tr>
<tr>
<td><strong>Wood Ties</strong></td>
<td>654,131,564</td>
<td>120,911,350</td>
<td>127,610,939</td>
<td>190,153,628</td>
<td>146,510,350</td>
<td>68,945,298</td>
</tr>
</tbody>
</table>
# Tonnage and Curvature Distributions

- Estimates based on a variety of industry sources

## Tonnage Category Distribution (%)

<table>
<thead>
<tr>
<th>Tonnage Category</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Tonnage Main Lines (&gt; 50 MGT)</td>
<td>34%</td>
</tr>
<tr>
<td>Moderate Tonnage Main Lines (20 to 50 MGT)</td>
<td>19%</td>
</tr>
<tr>
<td>Secondary Track</td>
<td>25%</td>
</tr>
<tr>
<td>Yards</td>
<td>22%</td>
</tr>
</tbody>
</table>

## Curvature Category Distribution (%)

<table>
<thead>
<tr>
<th>Curvature Category</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangent/Shallow (Tangent to less than 2°)</td>
<td>92%</td>
</tr>
<tr>
<td>Moderate (2° to less than 6°)</td>
<td>7%</td>
</tr>
<tr>
<td>Severe: (6° and above)</td>
<td>1%</td>
</tr>
</tbody>
</table>
## Creosote-Only Tie Lives

<table>
<thead>
<tr>
<th>Tonnage/Curve Category</th>
<th>Tan/Shal</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>38.6</td>
<td>34.7</td>
<td>28.1</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>43.1</td>
<td>39.4</td>
<td>32.8</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>46.1</td>
<td>42.9</td>
<td>37.0</td>
</tr>
<tr>
<td><strong>Yards</strong></td>
<td>49.0</td>
<td>47.0</td>
<td>43.3</td>
</tr>
<tr>
<td><strong>Weighted Average for Zone 1</strong></td>
<td><strong>43.3</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tonnage/Curve Category</th>
<th>Tan/Shal</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>35.5</td>
<td>32.0</td>
<td>26.0</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>39.7</td>
<td>36.3</td>
<td>30.2</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>42.5</td>
<td>39.6</td>
<td>34.2</td>
</tr>
<tr>
<td><strong>Yards</strong></td>
<td>45.1</td>
<td>43.3</td>
<td>40.0</td>
</tr>
<tr>
<td><strong>Weighted Average for Zone 2</strong></td>
<td></td>
<td><strong>39.9</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tonnage/Curve Category</th>
<th>Tan/Shal</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>32.0</td>
<td>28.8</td>
<td>23.4</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>35.8</td>
<td>32.6</td>
<td>27.1</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>38.3</td>
<td>35.6</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>Yards</strong></td>
<td>40.6</td>
<td>39.0</td>
<td>36.0</td>
</tr>
<tr>
<td><strong>Weighted Average for Zone 3</strong></td>
<td></td>
<td></td>
<td><strong>35.9</strong></td>
</tr>
</tbody>
</table>

- Calculated with RTA’s *TieLife* based on tonnage, curvature, and climate zone factor

### Tonnage/Curve Category

<table>
<thead>
<tr>
<th>Tonnage/Curve Category</th>
<th>Tan/Shal</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>27.3</td>
<td>24.6</td>
<td>20.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>30.6</td>
<td>27.9</td>
<td>23.3</td>
</tr>
<tr>
<td>Secondary</td>
<td>32.7</td>
<td>30.4</td>
<td>26.2</td>
</tr>
<tr>
<td>Yards</td>
<td>34.7</td>
<td>33.3</td>
<td>30.7</td>
</tr>
</tbody>
</table>

**Weighted Average for Zone 4:** 30.7

### Tonnage/Curve Category

<table>
<thead>
<tr>
<th>Tonnage/Curve Category</th>
<th>Tan/Shal</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>16.1</td>
<td>14.6</td>
<td>11.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>18.1</td>
<td>16.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>19.3</td>
<td>18.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Yards</td>
<td>20.5</td>
<td>19.7</td>
<td>18.2</td>
</tr>
</tbody>
</table>

**Weighted Average for Zone 5:** 18.1

### Climate Zone

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Average New Creosote-Only Tie Life (years)</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.3</td>
<td>19.5%</td>
</tr>
<tr>
<td>2</td>
<td>39.9</td>
<td>20.5%</td>
</tr>
<tr>
<td>3</td>
<td>35.9</td>
<td>28.1%</td>
</tr>
<tr>
<td>4</td>
<td>30.7</td>
<td>21.7%</td>
</tr>
<tr>
<td>5</td>
<td>18.1</td>
<td>10.2%</td>
</tr>
<tr>
<td>System-wide US Average</td>
<td>35.2</td>
<td>100%</td>
</tr>
</tbody>
</table>
Failure of Wood Ties Around the Average

- Forest Products Curve gives the distribution of wood tie failure
- Two standard deviations around the average account for 95% of all ties

<table>
<thead>
<tr>
<th>Tie Life Range in Terms of Standard Deviation (σ)</th>
<th>Percentage of All Ties Failing in this Range</th>
<th>Tie Life Range in Terms of Percentage of the Average New Tie Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1σ</td>
<td>68%</td>
<td>65.00% to 122.78%</td>
</tr>
<tr>
<td>±2σ</td>
<td>95%</td>
<td>46.67% to 140.77%</td>
</tr>
<tr>
<td>±3σ</td>
<td>99.8%</td>
<td>25.00% to 165.00%</td>
</tr>
</tbody>
</table>
### Range of Creosote-Only Tie Lives

- 95% of all creosote-only wood ties in each will fail in the range of years shown in the table

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Average New Creosote-Only Tie Life (years)</th>
<th>Range of Tie Lives for 95% of the Ties (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.3</td>
<td>20.2 to 61.0</td>
</tr>
<tr>
<td>2</td>
<td>39.9</td>
<td>18.6 to 56.2</td>
</tr>
<tr>
<td>3</td>
<td>35.9</td>
<td>16.8 to 50.5</td>
</tr>
<tr>
<td>4</td>
<td>30.7</td>
<td>14.3 to 43.2</td>
</tr>
<tr>
<td>5</td>
<td>18.1</td>
<td>8.5 to 25.5</td>
</tr>
<tr>
<td>US System-wide</td>
<td>35.2</td>
<td>16.4 to 49.6</td>
</tr>
</tbody>
</table>
# Treatability of Wood Ties

- Ties divided into four groups based on treatability

<table>
<thead>
<tr>
<th>Group Number</th>
<th>Treatability</th>
<th>Percentage of US Ties</th>
<th>Includes the Following Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Most Difficult</td>
<td>40.0%</td>
<td>White Oak, Hickory/Pecan (20%), Sweet Gum (80%), Black Locust, Mulberry, Hardy Catalpa, Beech, Poplar (Large Heart)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate Difficulty</td>
<td>17.5%</td>
<td>Red Oak (25%), Hickory/Pecan (80%), Sweet Gum (20%), Persimmon, Sassafras, Osage Orange, Birch, Honey Locust, Some Maples (Large Heart), Sycamore, Butternut, Kentucky Coffeetree, Boxelder</td>
</tr>
<tr>
<td>3</td>
<td>Relatively Easy</td>
<td>24.5%</td>
<td>Red Oak (45%), Black Gum/Tupelo Gum (20%), Ash, Basswood, Cork Elm, Some Maples, Hackberry</td>
</tr>
<tr>
<td>4</td>
<td>Easy</td>
<td>18.0%</td>
<td>Red Oak (30%), Black Gum/Tupelo Gum (80%), Elm</td>
</tr>
</tbody>
</table>
Life Extension with Dual-Treatment

- RTA studies have shown these life extension factors
- Reflects only environmental extension, not mechanical

<table>
<thead>
<tr>
<th>Treatability Group</th>
<th>Distribution</th>
<th>Climate Zone 5</th>
<th>Climate Zone 4</th>
<th>Climate Zone 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40.0%</td>
<td>2.8</td>
<td>2.5</td>
<td>1.7</td>
</tr>
<tr>
<td>2</td>
<td>17.5%</td>
<td>2.3</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>3</td>
<td>24.5%</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
<td>18.0%</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Weighted Average for Climate Zone</td>
<td>100%</td>
<td>2.1</td>
<td>1.9</td>
<td>1.4</td>
</tr>
</tbody>
</table>
### Projected US Wood Tie Lives Based on Dual-Treatment in Zones 3, 4, and 5

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Creosote-Only</th>
<th>Dual-Treated</th>
<th>Percent Increase from Dual-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.3</td>
<td>43.3</td>
<td>Not dual treated</td>
</tr>
<tr>
<td>2</td>
<td>39.9</td>
<td>39.9</td>
<td>Not dual treated</td>
</tr>
<tr>
<td>3</td>
<td>35.9</td>
<td>39.9</td>
<td>11.1%</td>
</tr>
<tr>
<td>4</td>
<td>30.7</td>
<td>39.9</td>
<td>30.0%</td>
</tr>
<tr>
<td>5</td>
<td>18.1</td>
<td>38.6</td>
<td>113.3%</td>
</tr>
<tr>
<td>US System-wide</td>
<td>35.2</td>
<td>40.4</td>
<td>14.8%</td>
</tr>
</tbody>
</table>

- Mechanical limit imposed whereby the dual-treatment life cannot exceed the life in Zone 2
# Replacement Rate for Creosote-Only Ties

<table>
<thead>
<tr>
<th>Zone</th>
<th>Total Wood Ties</th>
<th>Creosote-Only Tie Life (years)*</th>
<th>Replacement Ties Per Year</th>
<th>Cost Per Year at $110.00 Per Tie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 5</td>
<td>68,945,298</td>
<td>18.0</td>
<td>3,830,294</td>
<td>$421,332,375</td>
</tr>
<tr>
<td>Zone 4</td>
<td>146,510,350</td>
<td>30.0</td>
<td>4,883,678</td>
<td>$537,204,616</td>
</tr>
<tr>
<td>Zone 3</td>
<td>190,153,628</td>
<td>35.0</td>
<td>5,432,961</td>
<td>$597,625,687</td>
</tr>
</tbody>
</table>

*Tie lives rounded down to nearest whole integer for analytical purposes.
Summary

- Dual-treatment (Creosote-Borate & CuNap-Borate) has been shown in previous RTA/MSU studies to extend wood tie life, especially in the most severe decay zones (Zones 3 to 5).

- This analysis has shown that introduction of dual-treatment in zones 3, 4, and 5 would extend the US average wood tie life from 35.2 years to 40.4 years, an increase of 14.8%.

- Dual treatment in Zones 3, 4, and 5 would result in an economic benefit of 13 to 21 billion dollars (actual, not NPV). This would equate to 1 to 5 billion dollars in NPV depending on interest rates and dual treatment cost per tie.
Research

- Dual Treatment Economic Study is an Example of Economic Research
- RTA-AWPRP is an Example of Ongoing Product Development Research
RTA-AWPRP is about...
RTA-AWPRP is about...
RTA-AWPRP is about...
AND about this...

www.youtube.com/watch?v=hka7Ei2rIM&feature=related
Two Primary Goals

- Assess the relative performance of new preservative systems in direct comparison to existing creosote and borate/creosote systems in both refractory and non-refractory species

- Concurrently duplicate the research in a location where Formosan Subterranean Termites are known to be active
Project Sponsored by RTA and these companies

Participating Companies

KMG – Bernuth
Koppers -- Lonza -- Stella-Jones -- Nisus

Participating Railroads

BNSF == Canadian National == CSX
Norfolk Southern == Union Pacific
Ensure that each tie is exposed to decay

Ensure that each tie is exposed to termites (Formosan & Native)

Maximize the exposure risk for both types of deterioration
AWPA Hazard Class 4
Clay Soil
Activity by both decay and *Reticulitermes flavipes*

MSU Dorman Lake Test Site
RTA - AWPRP

Site 1
4th Year Inspection

Untreated Control with Severe Decay and Beetle Damage
RTA - AWPRP

Site 1
4th Year Inspection

Termite shelter tube in check
RTA - AWPRP

Site 1
4th Year Inspection

Sectioned Ties
Site 1
4th Year Inspection

Heavy decay in controls
RTA-AWPRP

Site 1
4th Year Inspection

Some ties still sound
Site 1
4th Year Inspection

Some treated ties showing signs of degradation in sapwood and around checks
RTA-AWPRP

Site 1
4th Year Inspection

Slight termite “grazing” on bottom
AWPA Hazard Zone 5
Sandy Loam Soil
Activity by both decay and
*Coptotermes formosanus*
Initial Setup

**Site 2:**

- OSB panels were placed on ground end-to-end
- SYP 2x4 or 2x6 were placed on OSB and allowed to weather
- Mulch was placed between SYP boards to the depth of the boards (and to the projected ends of the ties)
- Ties were separated by ~ 4” and treatment replicates randomly placed throughout test area
- Formosan termites were introduced to test setup because past studies have indicated foraging by Formosan is not as random and wide spread as natives
RTA - AWPRP

Site 2
6th Year Inspection

Overall (weathered)
Site 2
2nd Year Inspection

“Iron Degradation”
Site 2
6th Year Inspection
Untreated WO Decay
RTA - AWPRP

Site 2
6th Year Inspection
Untreated WO Decay
RTA - AWPRP

Site 2 4th Year Inspection

Sectioned Ties
Site 2
4th Year Inspection

Decay in sapwood
Site 2
4th Year Inspection
Decay in sapwood
Site 2
4th Year Inspection

Some ties still sound
RTA - AWPRP

Site 2
4th Year
Inspection

Some ties still sound
Site 2
4th Year Inspection

Some checks becoming severe
Site 2
4th Year Inspection

Decay around check
Site 2
6th Year Inspection

Decay around check
Site 2
6th Year
Inspection

Decay around check
PHASE II

Site 2

Installation of test Ties
10/8/12
PHASE II

Site 2

Overall 2-years after installation
AWPRP Phase II

- New treatments to be evaluated
  - Boron based treatments – The new 1 and 1.5 step process
  - ACZA (Ammoniacal Copper Zinc Arsenate) with and without borates and different oil combinations
In-Track Treatments

One way to approach the problem of pre-mature failure of ties is to identify and apply supplemental treatments to suspect ties during other operations, therefore minimizing track time.
In-Track Spray Treatments

30% BAE Solution at 1 Quart per Crosstie
Both ends of crosstie were cut through tie plate for evaluation
Borate Spray In-Track Treatment
Borate Spray In-Track Treatment

Treated End Was Solid

Untreated End Was Soft
In-Track Borate Treatment Summary for Jessup, GA Trial

- Borate Treatments arrested the growth of decay fungi that were present in treated ends of test ties
- Borate rods placed in holes drilled on either side of the plate proved to be very effective
- Borate paste, fluoride pads and copper/borate pads proved to be very effective
Creosote-treated ties compare

- Favorable to concrete ties for all indicators
- Primarily favorable to plastic/composite ties
- Favorable to P/C for total energy, GHG, fossil fuel, acid rain, water use, and ecological toxicity, smog and only slightly less favorable for eutrophication
# ELCA – Wood Crossties

<table>
<thead>
<tr>
<th></th>
<th>Creosote-treated tie</th>
<th>Concrete tie</th>
<th>Plastic/composite tie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gases</td>
<td>0.36</td>
<td>1.0</td>
<td>0.81</td>
</tr>
<tr>
<td>Fossil Fuel Use</td>
<td>0.40</td>
<td>0.76</td>
<td>1.0</td>
</tr>
<tr>
<td>Acid Rain</td>
<td>0.013</td>
<td>1.0</td>
<td>0.99</td>
</tr>
<tr>
<td>Water Use</td>
<td>0.10</td>
<td>0.84</td>
<td>1.0</td>
</tr>
<tr>
<td>Smog</td>
<td>0.42</td>
<td>1.0</td>
<td>0.49</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>0.49</td>
<td>1.0</td>
<td>0.36</td>
</tr>
<tr>
<td>Ecological Toxicity</td>
<td>-0.036</td>
<td>1.0</td>
<td>0.33</td>
</tr>
</tbody>
</table>

[Bar chart showing comparative environmental impacts of different types of railway ties.]
ELCA – Wood Crossties

- Peer Reviewed
- Journal of Transportation Technologies, 2013, 3, 149-161
- Published Online April 2013
- Open access journal at the above link,
- Click > 2013 > Issue 2 to download article.
RTA
Railway Tie Association