“Sustainable Highway Construction” is NOT an Oxymoron

Gary Demich, P.E.
H.W. Lochner, Inc.
“Sustainable Highway Construction” is NOT an Oxymoron

Today’s Topics

• Why Should We Worry About Sustainability?
• Is “Sustainable Highway” an Oxymoron?
• Can We Afford to be Green?
• Why Do We Need a Sustainability Rating System?
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Why Should We Worry About Sustainability?

Sustainability is not:

• A management technique
• A process to improve quality
• Thinking harder and working smarter
• Saving a few more trees or a few more fish
Why Should We Worry About Sustainability?

- Then what is it?

  The Brundtland Definition (1987)
  Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
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Why Should We Worry About Sustainability?

- Then what is it?
  - The Demich Metaphor (2009)

Don’t Eat the Seed Corn!

(The survival of humanity depends on it.)
Why Should We Worry About Sustainability?

• Why do we need it?
Why Should We Worry About Sustainability?

- Why do we need it?
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Why Should We Worry About Sustainability?

• Why do we need it?
  1. Finite amounts of virgin non-renewable resources.
     In 2008, the world economy consumed:
     - 2.4 billion tons of iron ore
     - 2.9 billion tons of cement
     - 1.2 billion tons of aggregates (USA only)
     - 1.3 trillion gallons of crude oil

Source: USGS
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Why Should We Worry About Sustainability?

- Why do we need it?
  1. Finite amounts of virgin non-renewable resources.
  2. Increasing population

The World & its 20 Largest Countries – July 1, 2009
(Descending Left to Right)

Source: GeoHive
Why Should We Worry About Sustainability?

- Is it a passing fad?
  1. Population
  2. Demands for higher standards of living
  3. Virgin raw material supply
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Is “Sustainable Highway” an Oxymoron?

Oxymorons...you know several:

- Jumbo...Shrimp
- Virtual...Reality
- Rolling...Stop
- Exact...Estimate
- Civil...Engineer
Is “Sustainable Highway” an Oxymoron?

Highway improvements lead to added sprawl, thus increasing energy use and GHG emissions. How is that part of being sustainable?

Regardless of how we might travel in the future, highways will be necessary for a long time. Implementing sustainability for today’s highways is as much about how we build them as why we build them.
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How can Highway Construction be Part of the Sustainability Solution?

• Maximizing
  o Reuse existing materials
  o Recycling of existing materials

• Minimizing
  o Use of virgin natural resources
  o Construction and demolition waste
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What Options are Available?

• Designing for lowest life-cycle impacts
• Minimizing construction & demolition waste
• Recycling asphalt paving materials
• Rehabilitating concrete roadways
• Rubblizing existing concrete pavements in place as base
• Recycling concrete as aggregate
• Modifying Diamond Interchanges to Double Crossover Diamonds
• Specifying sustainable coatings for structures
• Constructing bridges using recycled thermoplastic components
• Maximizing infiltration
• Specifying sustainable landscaping
• Choosing roundabouts instead of signals
• Using LED signals
• Using LED pedestrian and street lighting
• Generating clean energy on highway rights-of-way
• Performing environmental cleanup
• Reducing greenhouse gas generation
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What Options are Available?

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Double Crossover Diamond Interchange

Source: MoDOT Photos
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LED Street Lighting

Halifax, Nova Scotia

High Pressure Sodium 196 Watts

LED Lighting  88 Watts
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Recycled Plastic Bridge Components

Source: US Army
Photo Credit: Dawn Elizabeth Pandoliano
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Renewable Energy Generation on Unused Rights-of-Way

Source: ODOT
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A Current Example

Mid-Currituck Crossing
Owner: North Carolina Turnpike Authority
Finance / Construction: ACS / Dragados
Design: Lochner-MMM
Estimated Cost: $650 Million
Anticipated ROD: Fall 2011
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A Current Example

Undergoing serious consideration at Mid-Currituck

- Zero C & D Waste to the Landfill
- Porous Pavement for Stormwater Infiltration
- Precast Concrete
- Roundabouts in lieu of Signals
- LED Pedestrian and Roadway Lights
- In-Situ Contamination Removal
- Renewable Energy
- Low-Maintenance Landscaping
“When virgin resources become really scarce maybe future generations will make reuse/recycle decisions for economic reasons, but in today’s economy that would just be too expensive.”

- The skeptic
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Can We Afford to be Green?

What if you learned there are more sustainable ways to build projects that don’t cost more...or even cost less?

Would you adopt them?
Can We Afford to be Green?

A completed intersection/stormwater project:

- King County, WA Public Works, Military Road S at 272<sup>nd</sup> Street Intersection
  - LID Porous Pavements and Rain Gardens were chosen for the technology of being green, but saved an estimated $44,000 over conventional stormwater collection and treatment.
Can We Afford to be Green?

A more recent intersection/stormwater project:

• King County, WA Public Works, NE Woodinville-Duvall Road at Mink Road NE:
  o The initial project concept included a constructed wetland, but the adjacent owner did not want to sell the necessary property.
  o The County switched to a Rain Garden to handle stormwater at half the estimated cost.
    • Constructed Wetland Estimate: $160,000
    • Rain Garden Estimate: $80,000
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Can We Afford to be Green?

• A demolition and disposal project:
  o Nashville Thermal Transfer Corporation
    • Demolish an existing Waste-To-Energy plant
      • 200 ft. concrete stack
      • Waste receiving facility
      • Waste-handling crane
    • Goal: Minimize costs by recycling/reusing as much of the existing material as possible.
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Can We Afford to be Green?

Thermal Demo Summary
Materials Movement & Reuse/Recycle Rate

<table>
<thead>
<tr>
<th>Activity / Item</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auction (Recycled/Reused)</td>
<td>1,093</td>
</tr>
<tr>
<td>Demo Steel, Including Rebars &amp; Structural</td>
<td>4,394</td>
</tr>
<tr>
<td>Crushed Concrete Aggregate Produced</td>
<td>50,007</td>
</tr>
<tr>
<td>Demolition Debris to Landfill</td>
<td>983</td>
</tr>
<tr>
<td>Asbestos (Removed/Disposed at Landfill)</td>
<td>21</td>
</tr>
<tr>
<td>Scrapped Metal from Auction &amp; UST's</td>
<td>118</td>
</tr>
<tr>
<td>Railroad Ties</td>
<td>7</td>
</tr>
<tr>
<td>Crushed Asphalt Produced</td>
<td>9,747</td>
</tr>
<tr>
<td>Total Weight, All Materials</td>
<td>66,370</td>
</tr>
<tr>
<td>Total Weight, Recycled/Reused Materials</td>
<td>65,366</td>
</tr>
</tbody>
</table>

% Recycled/Reused (total tons) 98.5%
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Can We Afford to be Green?

<table>
<thead>
<tr>
<th>Overall Dismantlement Project Costs</th>
<th>Nashville Thermal WTE Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Year 2000 Demo Estimate</td>
<td>$2,400,000</td>
</tr>
<tr>
<td>Final Project Costs:</td>
<td></td>
</tr>
<tr>
<td>– UST</td>
<td>$128,000</td>
</tr>
<tr>
<td>– Asbestos Removal</td>
<td>$86,000</td>
</tr>
<tr>
<td>– Fencing</td>
<td>$13,000</td>
</tr>
<tr>
<td>– Demolition</td>
<td>$775,000</td>
</tr>
<tr>
<td>– Cover Dirt &amp; Seeding</td>
<td>$96,000</td>
</tr>
<tr>
<td>– Subtotal Cost</td>
<td>$1,098,000</td>
</tr>
<tr>
<td>– Internet Auction Income</td>
<td>($983,000)</td>
</tr>
<tr>
<td><strong>Actual Net Total Dismantlement Cost</strong></td>
<td><strong>$115,000</strong></td>
</tr>
</tbody>
</table>
Can We Afford to be Green?

- A recent project to replace 30 lane miles of existing asphalt on a two-lane highway.
  - CALTRANS Hwy 166, the challenge:
    - Full-depth replacement or rehabilitation needed.
    - Widen existing lanes, add new shoulders.
    - One lane must be open to traffic at all times.
    - 4 days/week work limit due to heavy traffic.
A recent project to replace 30 lane miles of existing asphalt on a two-lane highway.

CALTRANS Hwy 166, the solution:

- Cold Foamed In-Place Recycled (CFIPR) Asphalt base.
- Grind to 11” to 12” deep.
- Add cement and CFIPR.
- Compact (cold) material.
- Finish with HMA wearing course.
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Can We Afford to be Green?

- A recent project to replace 30 lane miles of existing asphalt on a two-lane highway.
  - CALTRANS Hwy 166, the benefits:
    - 30 lane miles in 20 work days minimized disruption.
    - Minimized virgin materials needed by reusing existing aggregates and foamed asphalt.
    - Eliminated the costs and GHG’s associated with hauling old materials out and new base material in.
    - Total cost was between 50% and 60% of traditional full-depth replacement.
Can We Afford to be Green?

For reasons having to do with:
• greater long term environmental benefits,
• lower life-cycle cost, and
• *in many cases lower current cost*,

*Can we afford not to?*
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Why Do We Need a Sustainability Rating System?
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Why Do We Need a Sustainability Rating System?

We don’t know yet how to be 100% sustainable and we’re not going to be able to change that overnight.
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We are currently in the state of being "Now" and our goal is to move towards the future. The rating system helps us to assess how sustainable a project is, whether it's "Less Bad," "A Lot Less Bad," or fully sustainable. The green area represents the "Less Bad" state, and the white area represents the "A Lot Less Bad" state. The sustainability rating system helps us to prioritize and make informed decisions to improve our current state and move towards a more sustainable future.
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Why Do We Need a Sustainability Rating System?

We don’t know yet how to be 100% sustainable and we’re not going to be able to change that overnight.
Which Rating System Should I Use?

• Buildings
  • BREEM (1990)
  • LEED (1998)
  • Green Globes (2005)

• Roads
  • CEEQUAL (2003, 2010)
  • GreenLITES (2008)
  • STEED (2008, 2010)
  • I-LAST (2010)
  • GreenRoads (2010)
  • FHWA (Beta version just out)
  • ASCE/ACEC/APWA (Coming soon)
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Which Rating System Should I Use?

Which system you use is not as important as How you use it.

• Roads
  • CEEQUAL (2003, 2010)
  • GreenLITES (2008)
  • STEED (2008, 2010)
  • I-LAST (2010)
  • GreenRoads (2010)
  • FHWA (Beta version just out)
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OK...How **Should** I Use a Rating System?

**S**ustainable  
**T**ransportation  
**E**ngineering &  
**E**nvironmental  
**D**esign
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STEED

- 2008, revised 2010
- H.W. Lochner, Inc.
- Voluntary
- 35 pages
- Organized by “Sustainability Categories”
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Selected Scoring Elements

In order to have clear, measureable rating elements, Lochner further subdivides each of these criteria.

Dozens of elements are considered, with the following 21 elements identified as representing the most significant issues to consider.

<table>
<thead>
<tr>
<th>Environmental Quality</th>
<th>Social Quality</th>
<th>Economic Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Quality</td>
<td>Aesthetics &amp; Livability</td>
<td>Life-Cycle Considerations</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Cultural &amp; Historic Preservation</td>
<td>Construction Duration</td>
</tr>
<tr>
<td>Energy</td>
<td>Equity</td>
<td>Freight Mobility</td>
</tr>
<tr>
<td>Environmental Cleanup</td>
<td>Land &amp; Geology</td>
<td>Innovative Use of Technology &amp; Design</td>
</tr>
<tr>
<td>Light &amp; Noise</td>
<td>Land Use/Transportation Integration</td>
<td>Multiple Modes &amp; Modal Connectivity</td>
</tr>
<tr>
<td>Material Sources &amp; Reuse</td>
<td>Public Involvement</td>
<td>Operations &amp; Maintenance</td>
</tr>
<tr>
<td>Water Resources</td>
<td>Safety &amp; Security</td>
<td>User Economic Impacts</td>
</tr>
</tbody>
</table>

Descriptions of each of these elements are found throughout this booklet.

Users may find that the goals of some scoring elements appear to be in conflict with others. Such conflicts are inevitable in virtually every human endeavor, and the scoring system within STEED recognizes that the goals of any given element will not always align with those of another. This is a fundamental reason why sustainability measure systems seek to balance decision-making criteria.
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Environmental Quality Rating Sheet

Material Sources & Reuse

Transportation projects often use significant amounts of materials. Some of the materials used are recyclable—some of the materials are renewable, and some are not. Consideration must be given to the avoidance of hazardous materials, use of recycled and longer-lasting materials and an overall reduction in construction waste.

The goals are to minimize use of non-renewable materials and maximize the re-use or recycling of existing materials.

Project Element Description
Provide a description of the elements of your project in which Materials Sources & Reuse is important and supporting information on how the selected elements are addressed. Points are awarded for measures selected below only when the selection is accompanied by a description of how that measure is being achieved on this specific project.

Rating—Each selected measure adds 1 point.

PEDA

☐ ☐ ☐ ☐ Wherever possible the design avoids the use of materials that may cause harm to people, plants, or animals if released into the environment.
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STEED

Rating—Each selected measure adds 1 point.

P E D A

☐ ☐ ☐ ☐ Wherever possible the design avoids the use of materials that may cause harm to people, plants, or animals if released into the environment.

☐ ☐ ☐ ☐ Specific provisions to encourage the use of locally-sourced (extracted/manufactured) materials are included, thereby supporting the local economy and reducing haul impacts.

☐ ☐ ☐ ☐ Existing paving materials, such as concrete or asphalt are reused or recycled within this project’s construction.

☐ ☐ ☐ ☐ More than 90% of the existing paving materials such as concrete or asphalt are reused or recycled within this project’s construction. (A point is awarded for both the statement above and this statement when more than 90% of existing paving materials are resused.)

☐ ☐ ☐ ☐ Other existing materials and/or fixtures are reused within this project’s construction or are preserved at a location and in a condition that will enable their resuse by others.

☐ ☐ ☐ ☐ Methods for minimizing construction and demolition waste that would otherwise be taken to a landfill or incinerator are used.

☐ ☐ ☐ ☐ Less than 20% by weight of the construction and materials from demolished structures are disposed of via landfilling or incineration. (A point is awarded for both the statement above and this statement when less than 20% of existing materials are landfilled or destroyed.)

☐ ☐ ☐ ☐ The design prioritizes the use of renewable and minimizes the use of non-renewable resources.

P = Planning E = Environmental D = Design A = As-Built

STEED (Sustainable Transportation Engineering & Environmental Design rating system)
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STEED

• 2008, revised 2010
• H.W. Lochner, Inc.
• Voluntary
• 35 pages
  • Organized by “Sustainability Categories”
  • Combination Explanation & Checklist
• No Arbitrary “Award Levels” (Silver, Gold, etc.) that can:
  • Change the Goal
  • Offer a False Sense of Achievement
  • Limit the Imagination
  • Encourage Inappropriate Value Engineering
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  • Change the Goal
  • Offer a False Sense of Achievement
  • Limit the Imagination
  • Encourage Inappropriate Value Engineering
• Four-stage process (parallels the typical Project Delivery process)
  • Planning phase
  • Environmental phase
  • Design phase
  • Construction phase
“Sustainable Highway Construction” is NOT an Oxymoron

STEED

Rating - Each selected measure adds 1 point.

P E D A

Wherever possible the design avoids the use of materials that may cause harm to people, plants, or animals if released into the environment.

Specific provisions to encourage the use of locally-sourced (extracted/manufactured) materials are included, thereby supporting the local economy and reducing haul impacts.

Existing paving materials, such as concrete or asphalt are reused or recycled within this project's construction.

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Other existing materials and/or fixtures are reused within this project’s construction or are preserved at a location and in a condition that will enable their reuse by others.

Methods for minimizing construction and demolition waste that would otherwise be taken to a landfill or incinerator are used.

Less than 20% by weight of the construction and materials from demolished structures are disposed of via landfilling or incineration. (A point is awarded for both the statement above and this statement when less than 20% of existing materials are landfilled or destroyed.

The design prioritizes the use of renewable and minimizes the use of non-renewable resources.

P = Planning ___________________ E = Environmental ___________________ D = Design ___________________ A = As-Built ___________________

STEED (Sustainable Transportation Engineering & Environmental Design rating system)

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Why a Four-Stage Evaluation is Critical

- Goal: Sustainability
- Tool: Continuous Improvement – PDCA Cycle
  - End of Project evaluation only
    - This is what we got.
  - Two-stage evaluation
    - This is what we intended, this is what we got.
  - Four-stage evaluation (Planning, Environmental, Design, As-Built)
    - This is what we intended, this is what we got, and here’s where in the process the goal changed and how it changed.
    - Useful information for making future projects more sustainable.
Food for Thought

- The need to act sustainably isn’t going to go away.
- Sustainability in highway construction is the right thing to pursue.
- We can and should save virgin materials for their highest and best uses.
- We can and should recycle/reuse existing materials to their highest and best uses.
- We can afford to do many of the things I’ve identified today within our existing budgets.
Sustainability & Highway Owners...

- Pick a Rating System that will help focus your efforts
- Be aware of the pitfalls associated with targeting less-than-“sustainable” award levels & avoid them
- Evaluate the project’s score at the end of each major phase (regardless of whether the system you picked calls for it or not)
- And remember that we won’t become sustainable doing nothing...GET ON BOARD & GET MOVING!
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Sustainability & Highway Professionals...

• It’s coming soon to a project you’ll be working on.
• It’s coming in a relatively short time to every project you’ll be working on.
• It’s the right thing to do for all the right reasons.
• “Sustainable Highway Construction” is NOT an Oxymoron...it’s a NECESSITY.
• GET ON BOARD & GET MOVING!
Thank you!

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Questions?