Sustainable Highway Construction Practices

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AZ Pavements/Materials Conference

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what is sustainability?

why sustainability?

what is being done in highways?

Sustainable highway construction practices

strategies

local connection

moving forward

assessment

What’s the big deal?
Definitions

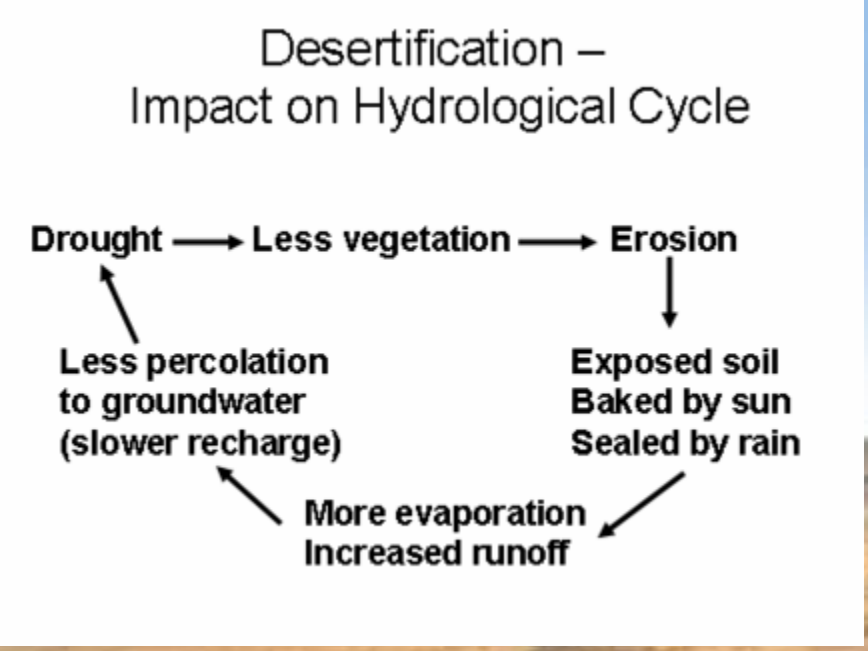
Formerly one of the four largest lakes in the world with an area of 68,000 square kilometers (26,300 sq mi), the Aral Sea has been steadily shrinking since the 1960s after the rivers that fed it were diverted by Soviet irrigation projects.

By 2007, it had declined to 10% of its original size.

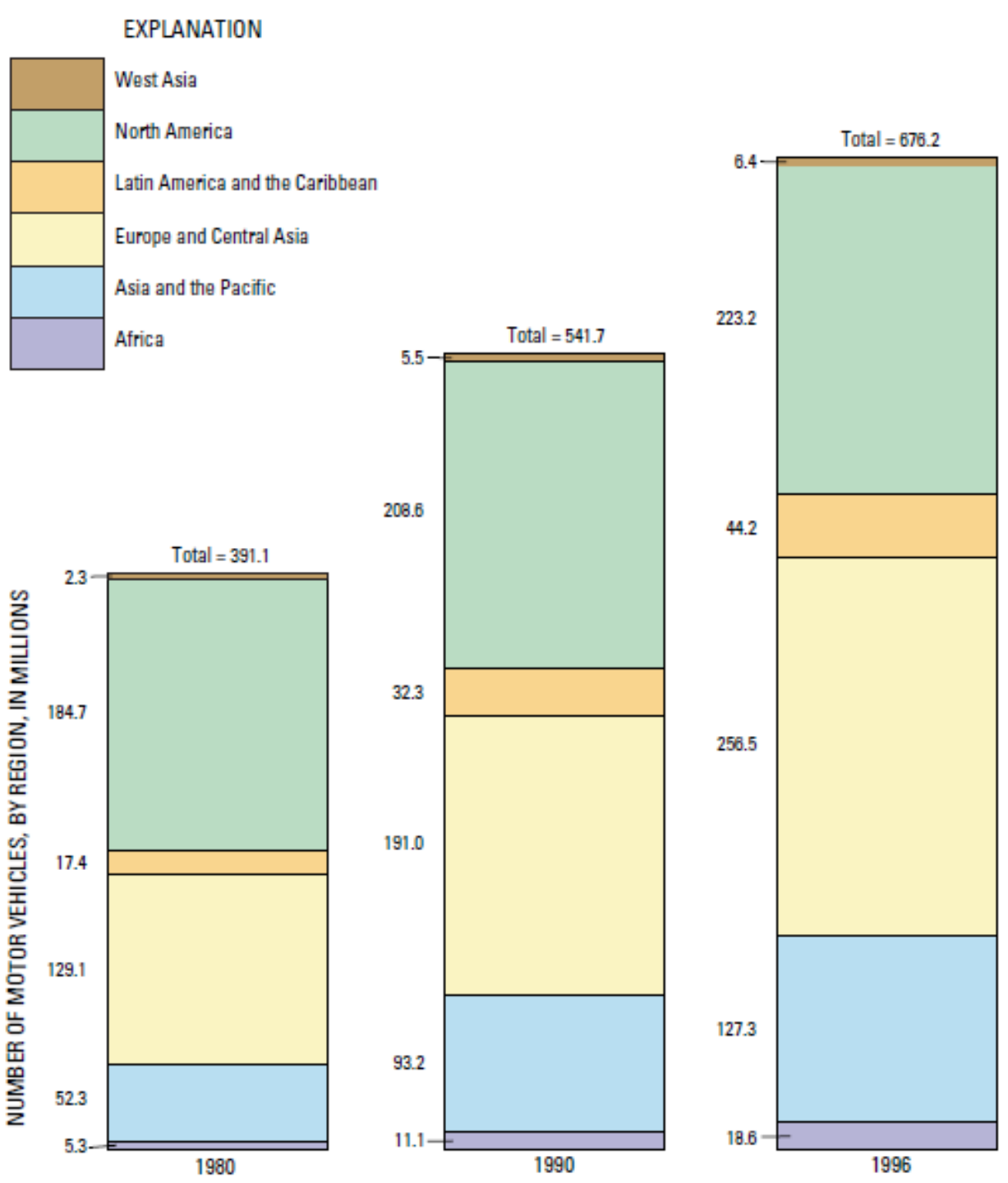
Deforestation in *Kalimantan Indonesia*

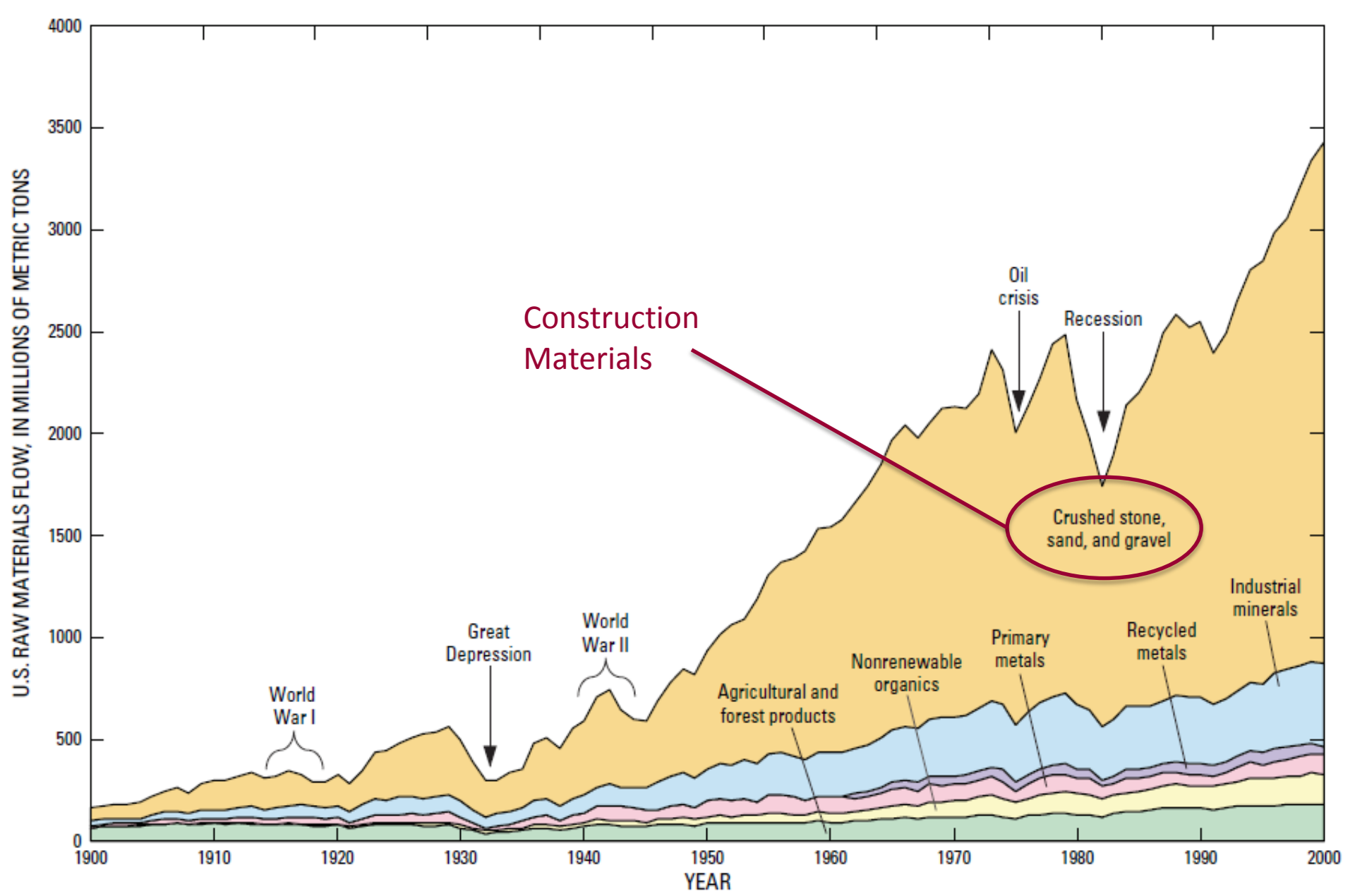
Rhett A. Butler / mongabay.com

Desertification – Impact on Hydrological Cycle



Number of Cars By Region In Millions



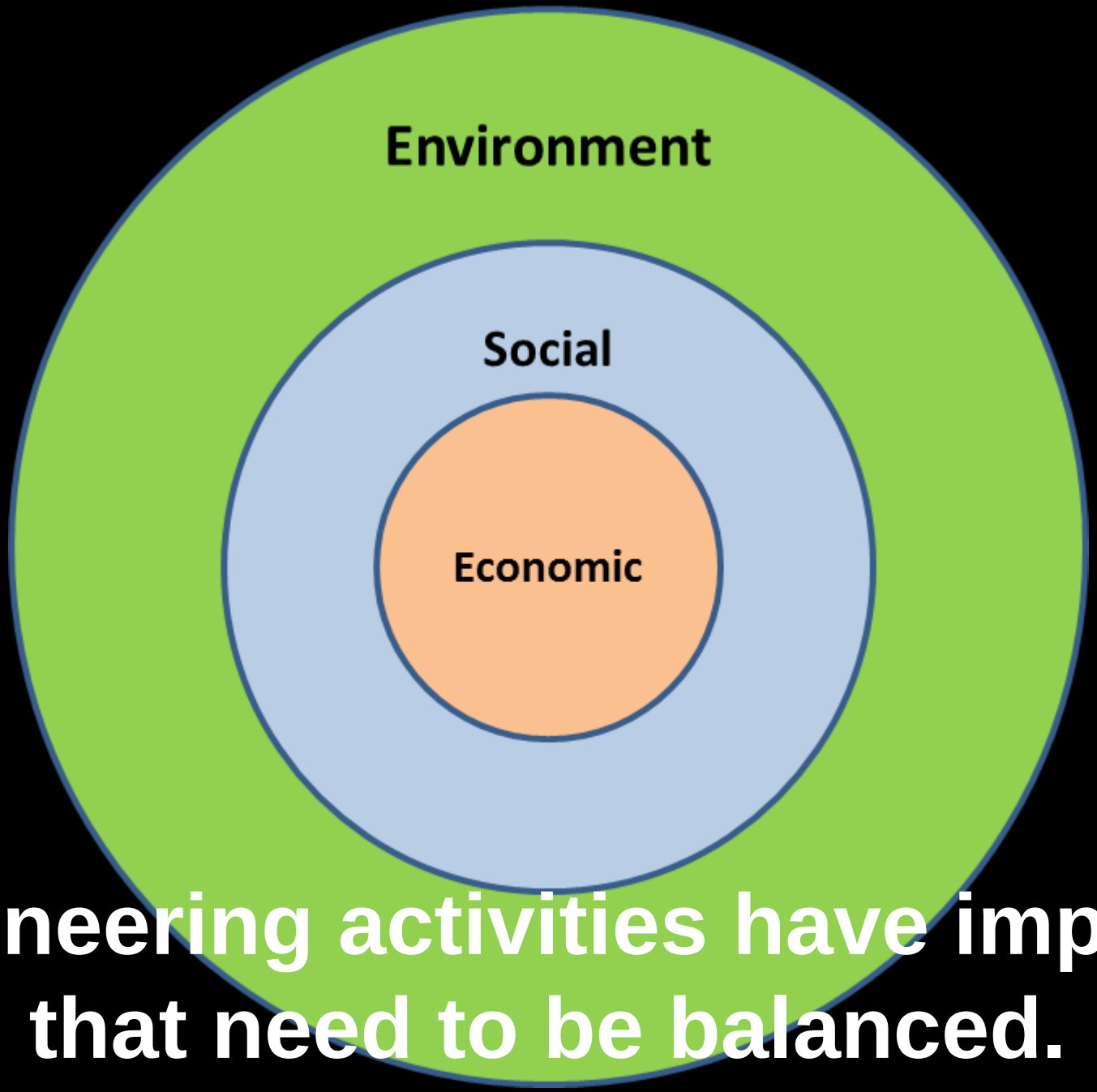


Wagner, L.A (2002) *Materials in the Economy – Material Flows, Scarcity and the Environment*.

We have finite resources and we are extracting more and more to satisfy an increasing population and standard of living.

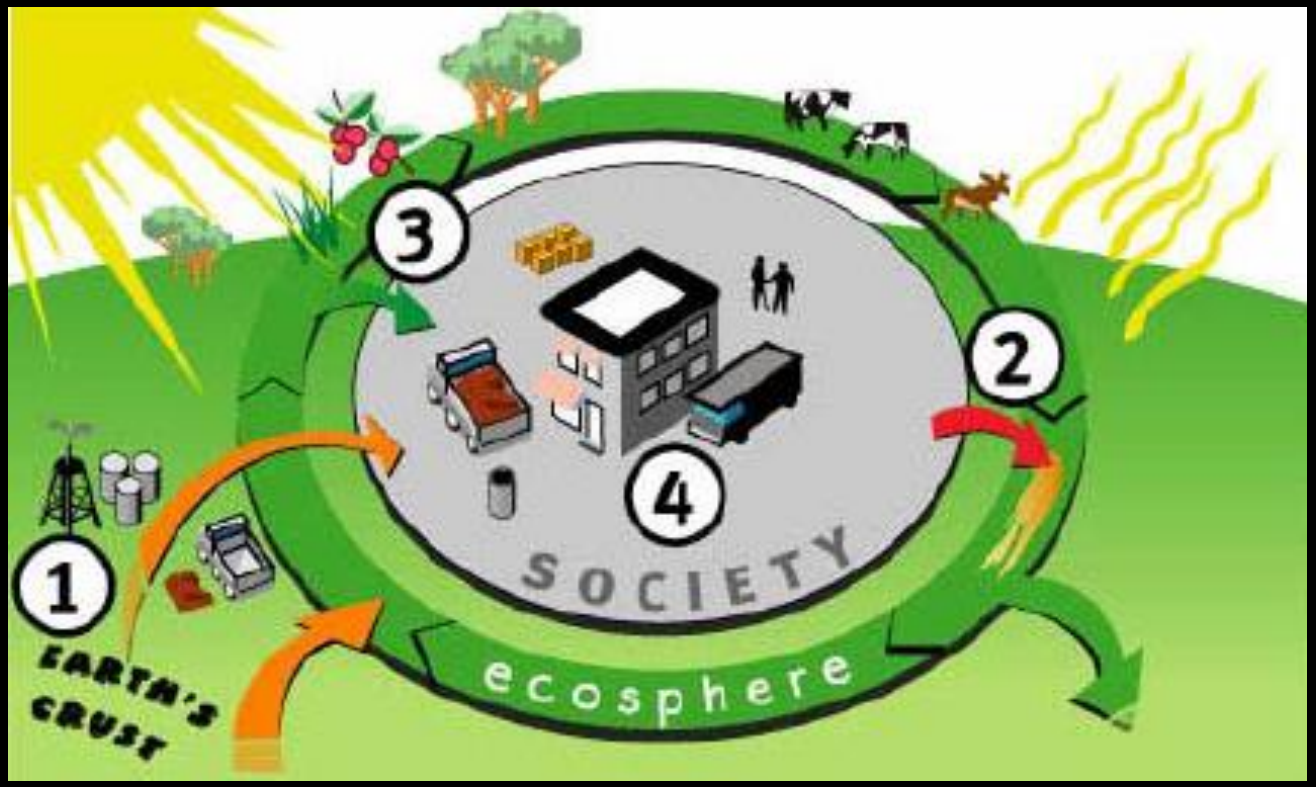
Number of earths needed to sustain such development

Promise of such economic development is unrealizable without dramatic change in our approaches and management systems…



Engineering activities have impacts that need to be balanced.

1. concentrations of substances extracted
2. concentrations of substances produced
3. degradation by physical means
4. people's ability to meet needs not undermined



The Natural Step **Four** System Conditions

The scientist's perspective: Dr. Karl Henrik Robert

Measurement Methods
Evaluating Sustainability

4 certification levels

- Platinum > 80 points
- Gold 60–79 points
- Silver 50–59 points
- Certified 40–49 points

ASU Fulton Center

LEED Certified

Sustainable Sites — Possible Points: 26

Y	?	N			
Y			Prereq 1	Construction Activity Pollution Prevention	
			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Roon	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Ve	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
			Credit 6.1	Stormwater Design—Quantity Control	1
			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
			Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N			
Y			Prereq 1	Water Use Reduction—20% Reduction	
			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
			Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
			Credit 1	Optimize Energy Performance	1 to 19
			Credit 2	On-Site Renewable Energy	1 to 7
			Credit 3	Enhanced Commissioning	2
			Credit 4	Enhanced Refrigerant Management	2
			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N			
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Element	1
			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
			Credit 4	Recycled Content	1 to 2
			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
			Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
			Credit 3.1	Construction IAQ Management Plan—During Construction	1
			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Product	1
			Credit 5	Indoor Chemical and Pollutant Source Control	1
			Credit 6.1	Controllability of Systems—Lighting	1
			Credit 6.2	Controllability of Systems—Thermal Comfort	1
			Credit 7.1	Thermal Comfort—Design	1
			Credit 7.2	Thermal Comfort—Verification	1
			Credit 8.1	Daylight and Views—Daylight	1
			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1

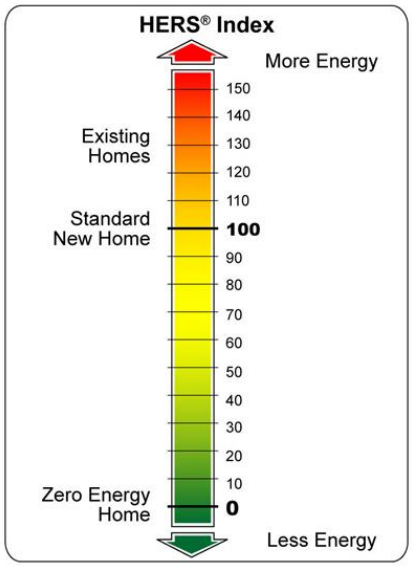
Total — Possible Points: 110

LEED is not alone.

green star
environmental rating system for buildings

HQE
ASSOCIATION
RECONNUE D'UTILITÉ PUBLIQUE

SCOTTSDALE
GREEN BUILDING
PROGRAM



U.S. GREEN BUILDING COUNCIL
LEED CERTIFIED
2007

energy
ENERGY STAR

Ehy is n on

GREEN GLOBE
CERTIFIED

CODE FOR A SUSTAINABLE BUILT ENVIRONMENT
BREEAM
BRE GLOBAL
AWARD WINNER 2012
WALES

NETZERO
ENERGY BUILDING
CERTIFICATION℠

iiSBE

LIVING
BUILDING
CHALLENGE

Highway rating systems share many of the same characteristics as vertical construction ratings, but focus on highway specific issues.

Highway Rating Systems

Green LITES: New York State DOT, 2008

Green Leadership In Transportation and Environmental Sustainability

Greenroads: Washington State DOT, 2010

I-LAST: Illinois DOT , 2011

"Infrastructure Voluntary Evaluation Sustainability Tool"

INVEST: FHWA, 2012

Federal Highway Administration, U.S. Department of Transportation

INVEST Sustainable Highways Self-Evaluation Tool

Highway Rating Systems

Green Guide for Roads: Alberta

Green Pave: Ontario Ministry of Transportation

Green Guide for Roads: Transportation Association of Canada

envision™

ISI INSTITUTE FOR SUSTAINABLE INFRASTRUCTURE

Greenroads®

Sustainability rating system for ALL roadways projects, including new, reconstruction and rehabilitation (even overlays), bridges, etc.

Project-focused: design and construction (vs. planning and operation)

Realizes we are not being sustainable yet

– just more sustainable that we used to be…

Project Requirements

Voluntary Credits 108 Points

- Environment and Water (21)
- Access and Equity (30)
- Construction Activities (14)
- Materials & Resources (23)
- Pavement Technologies (20)

Custom Credit 10 Points

Maximum Achievable: 118 Points

Greenroads Manual

Download Credit

PR-4: Quality Control Plan

Credit

Goal

Have a process in place to monitor and improve construction quality.

Requirements

The prime contractor shall establish, implement, and maintain a formal construction Quality Control Plan (QCP). The QCP must address the following quality control elements:

1. Key quality control personnel, their responsibilities and their qualifications (résumés, certifications, etc.)..
2. Procedures used to control quality during construction including (as a minimum):
   a. Items to be monitored (including pavement mix designs)
   b. Testing to be done (including testing standards and frequency)
   c. When corrective action is required (action limits)
   d. Procedures to implement corrective action
   e. Procedures to modify QCP if ineffective or when modifications are necessary

Resources

Quality Control Plan Example

Documentation

Copy of the contractor Quality Control Plan.

Browsing the Manual

You may also want to Comment on the manual or Rate a project.

Project Requirements

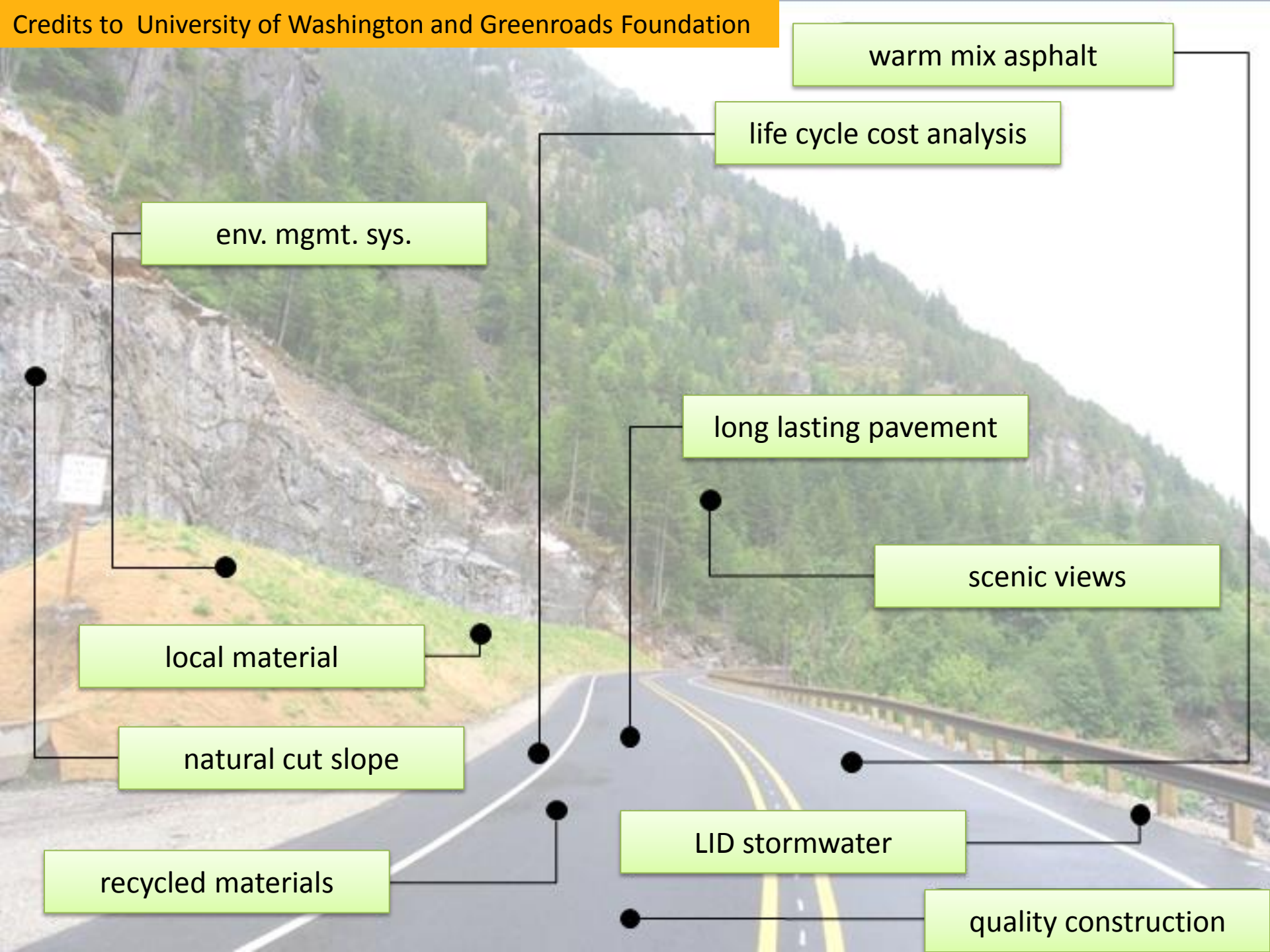
About Project Requirements
PR-1 Environmental Review Process
PR-2 Lifecycle Cost Analysis
PR-3 Lifecycle Inventory
PR-4 Quality Control Plan
PR-5 Noise Mitigation Plan
PR-6 Waste Management Plan
PR-7 Pollution Prevention Plan
PR-8 Low Impact Development
PR-9 Pavement Management System
PR-10 Site Maintenance Plan
PR-11 Educational Outreach

Environment & Water
Access & Equity
Construction Activities
Materials & Resources
Pavement Technologies
Custom Credit

Strategies

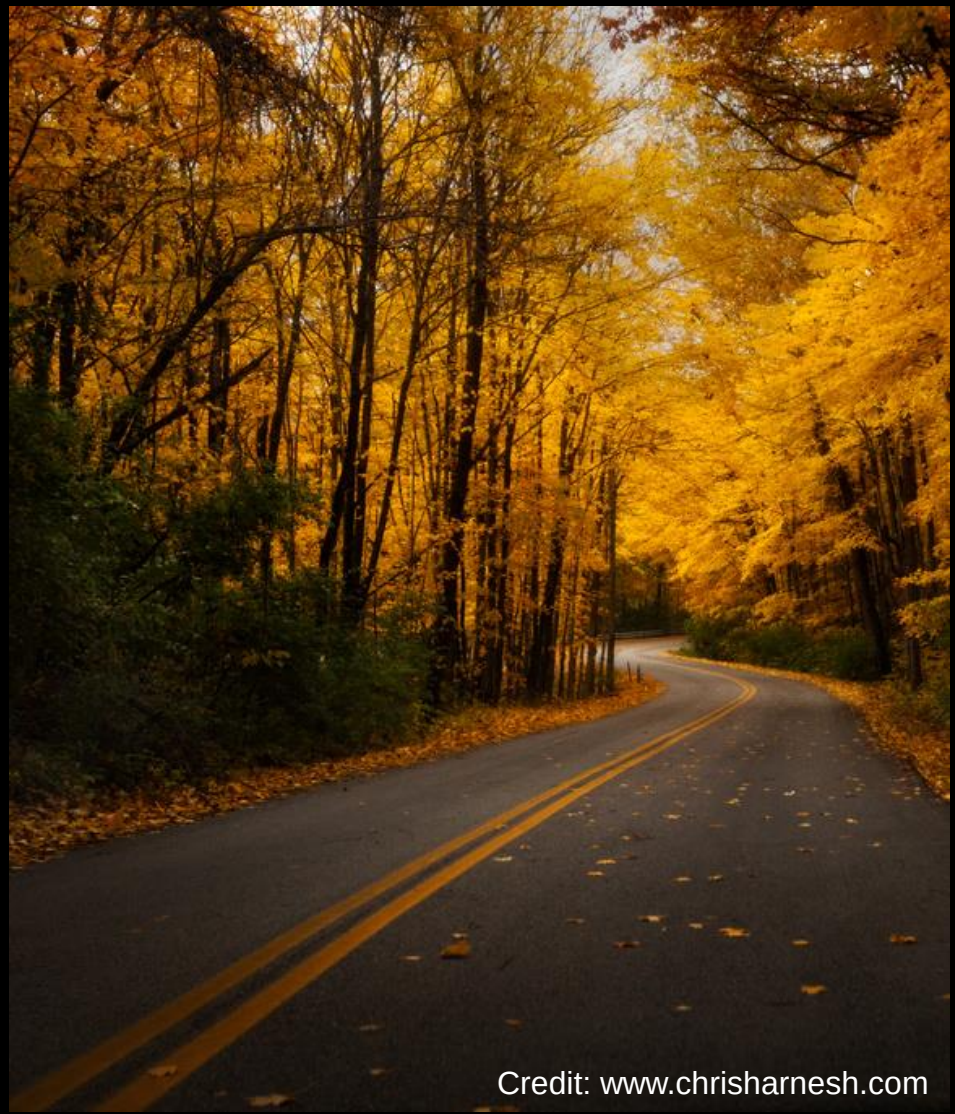
Current practices for sustainable highways

Credits to University of Washington and Greenroads Foundation



Will the sustainability issues in these two places be the same?

Credit: Sam Clemens



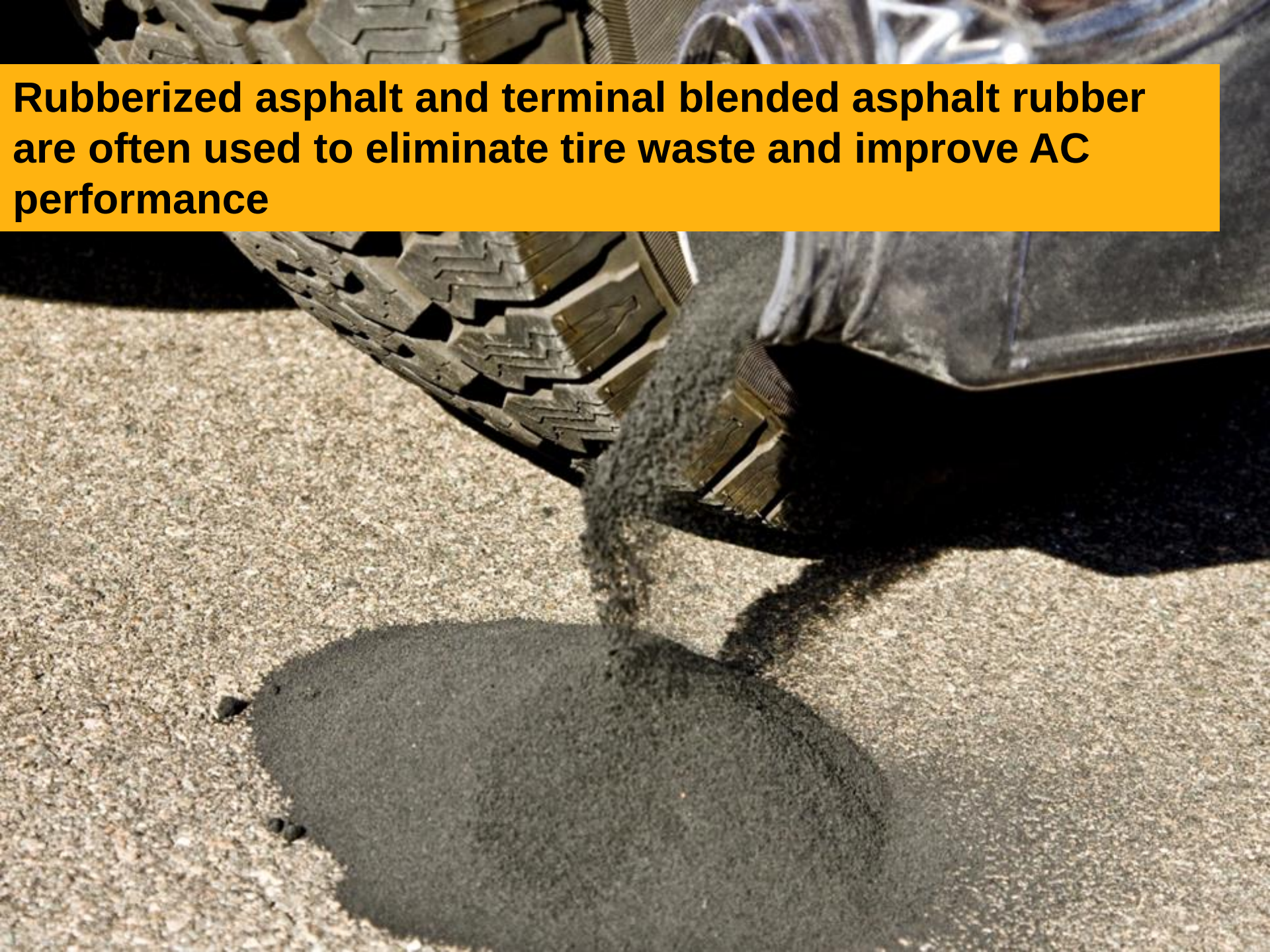
Credit: www.chrisharnesh.com

Reclaimed Asphalt Pavements (RAP) and Recycled Concrete Aggregate (RCA) can be reused in different pavement materials to reduce the consumption of new materials.

Image Source: Dale Rand TXDOT

Recycled Asphalt Shingles (RAS) are estimated to have saved 1.5 million barrels of asphalt binder between 2009 and 2010*

**Source: National Asphalt Pavement Association*



Rubberized asphalt and terminal blended asphalt rubber are often used to eliminate tire waste and improve AC performance

Glassphalt may include up to 20% by weight of recycled glass and is meant for low speed and medium volume roads*

**Source: Day and Schaffer*

Image Source: Zombie37, Flickr

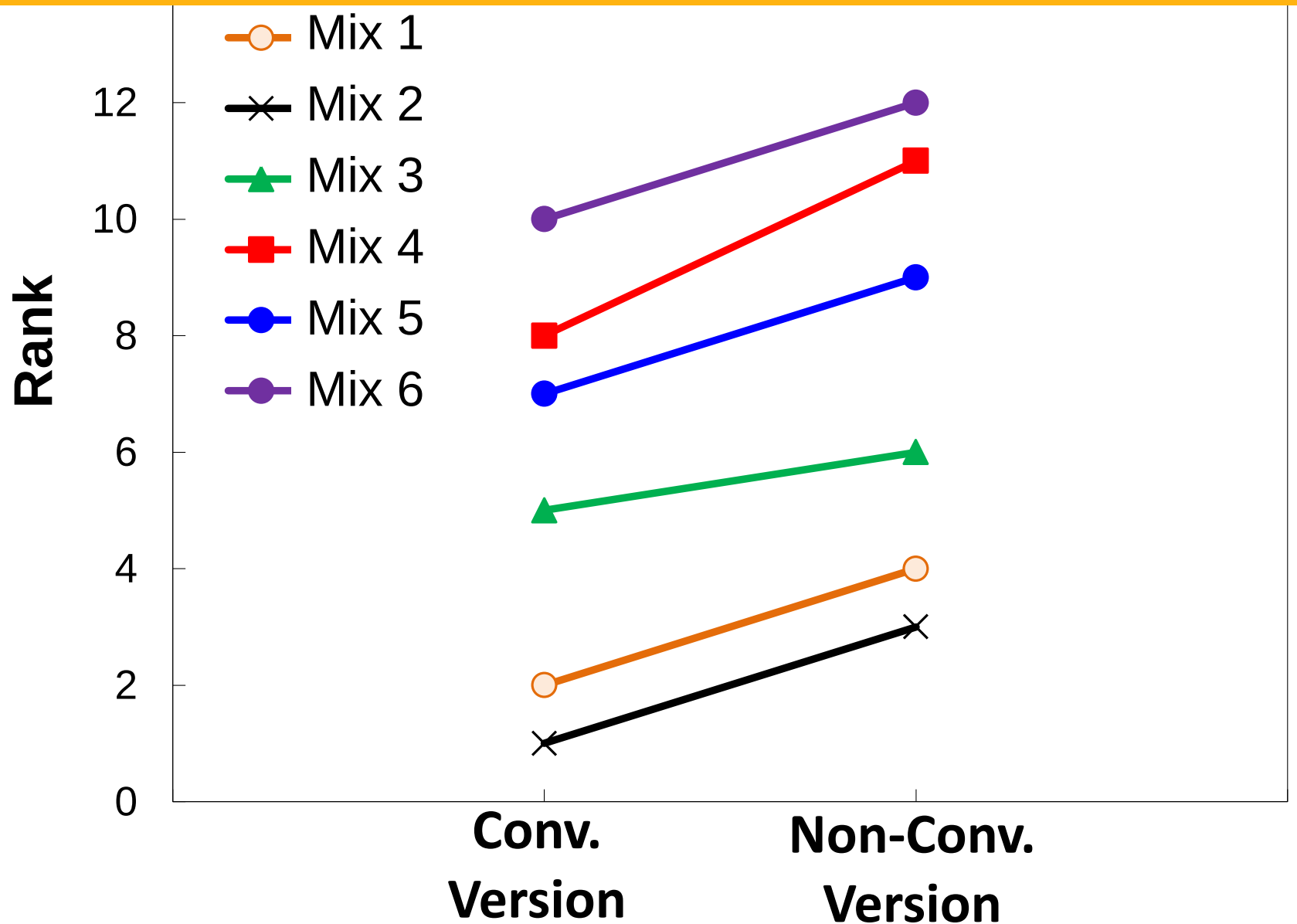
It is estimated by some that the term warm mix asphalt concrete will disappear in 3-5 years because all asphalt concrete mixtures will be made with these technologies.

Quiet pavements reduce societal impacts and can reduce the need for additional construction impacts from noise barriers

Source: Kevin McGhee

Service life performance must be established to evaluate true long-term effectiveness of these strategies

Mixes developed using these non-conventional and waste materials should be carefully reviewed for potential performance impacts

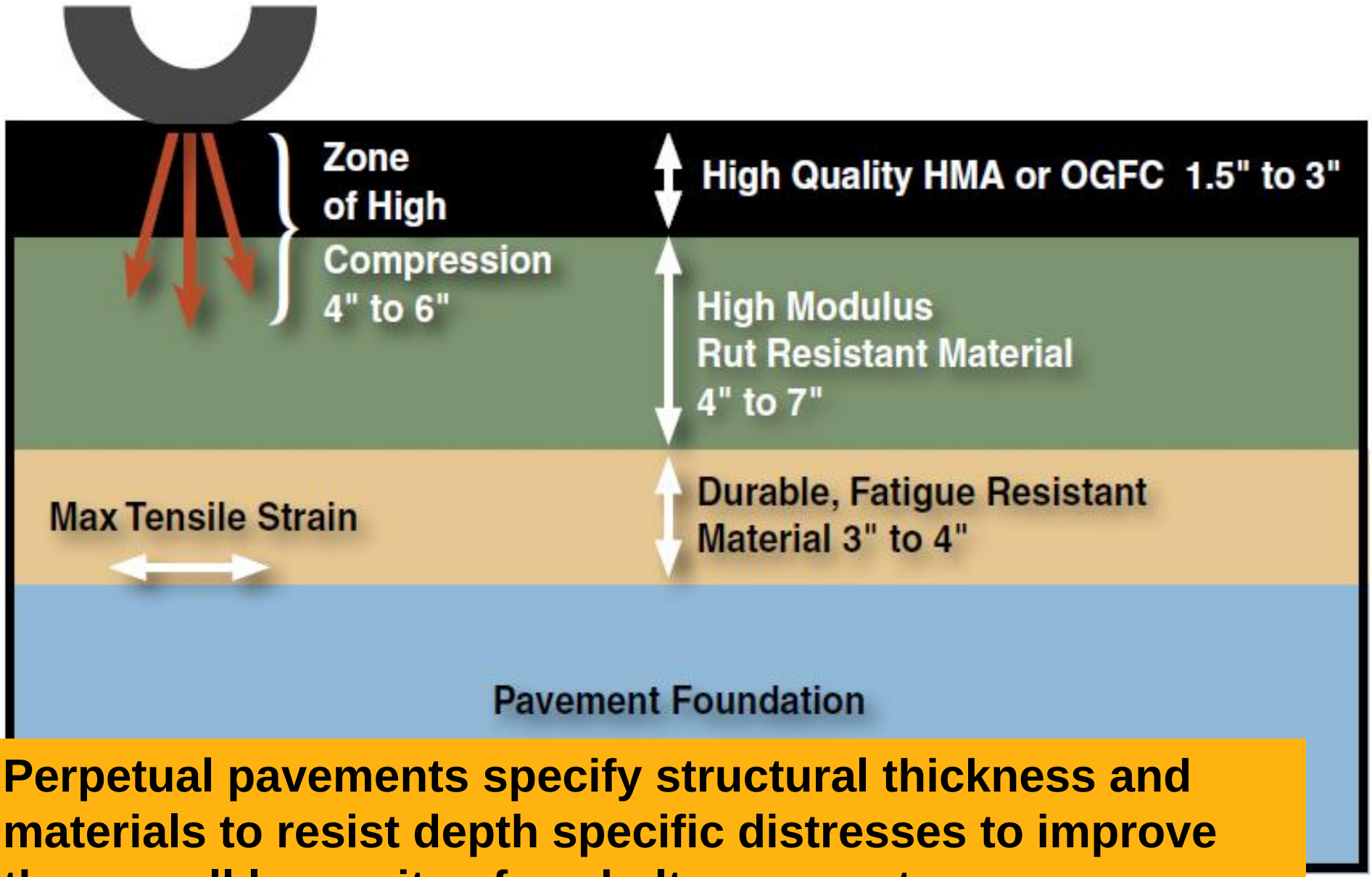


Pavement design, management, and maintenance

strategies include extending long term performance

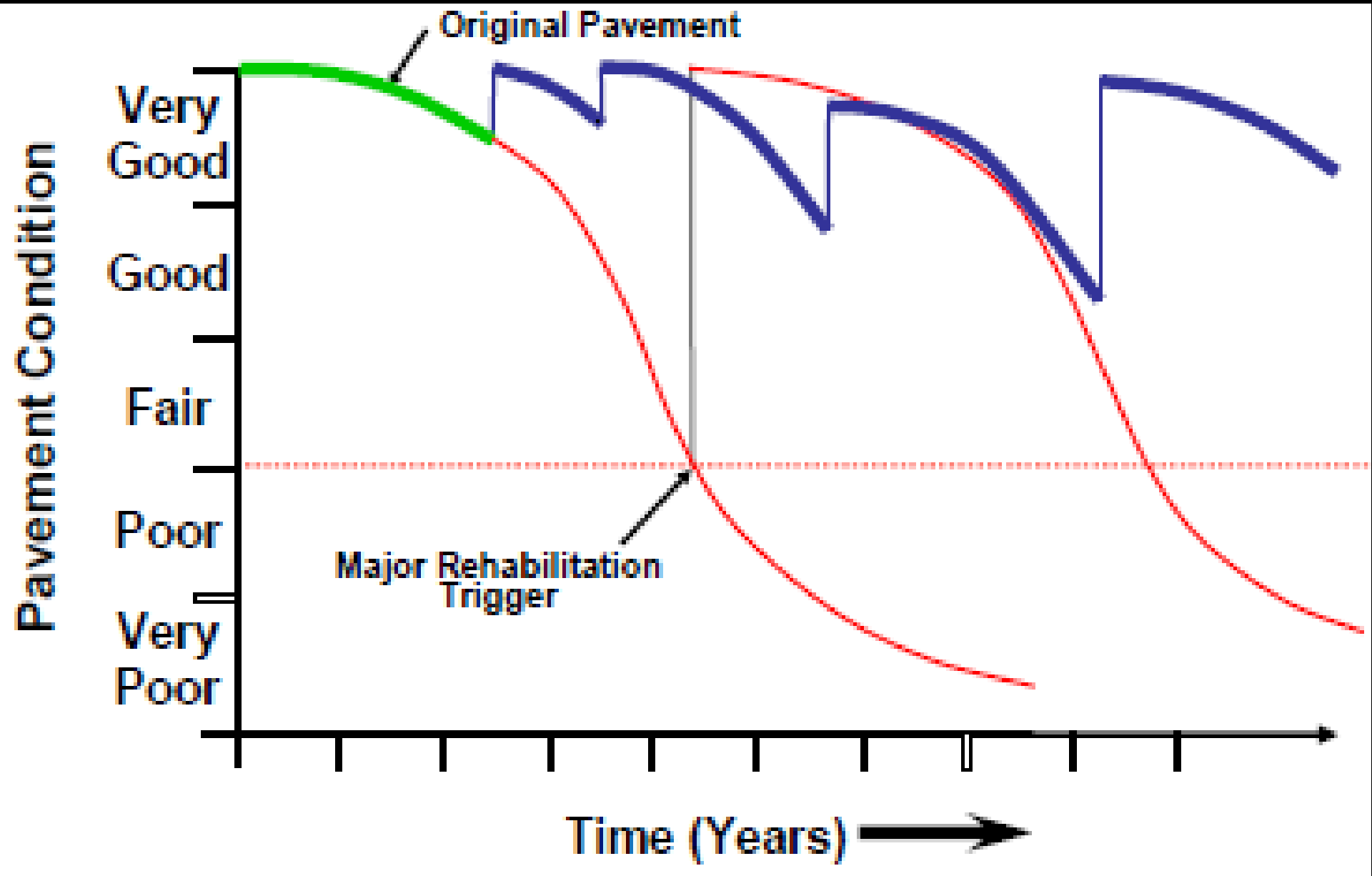
through perpetual pavements and pavement preservation

(Newcomb et al, 2000)



Perpetual pavements specify structural thickness and materials to resist depth specific distresses to improve the overall longevity of asphalt pavements

Pavement preservation strategies reduce the long term economic and social impacts of highways



Construction practices can be followed to reduce the short and long-term impacts of highway infrastructure

Training personnel to identify environmental issues and best practice methods to minimize environmental impacts

Picture Credits to University of Washington and Greenroads Foundation; http://www.greenroads.org/

Maintain and follow a site recycling plan to reduce construction-related waste destined for landfill

Picture Credits to Vermont Waste Management Division; http://www.anr.state.vt.us/dec/wastediv/

Reduce the overall consumption of fossil fuels by non-road construction equipment.

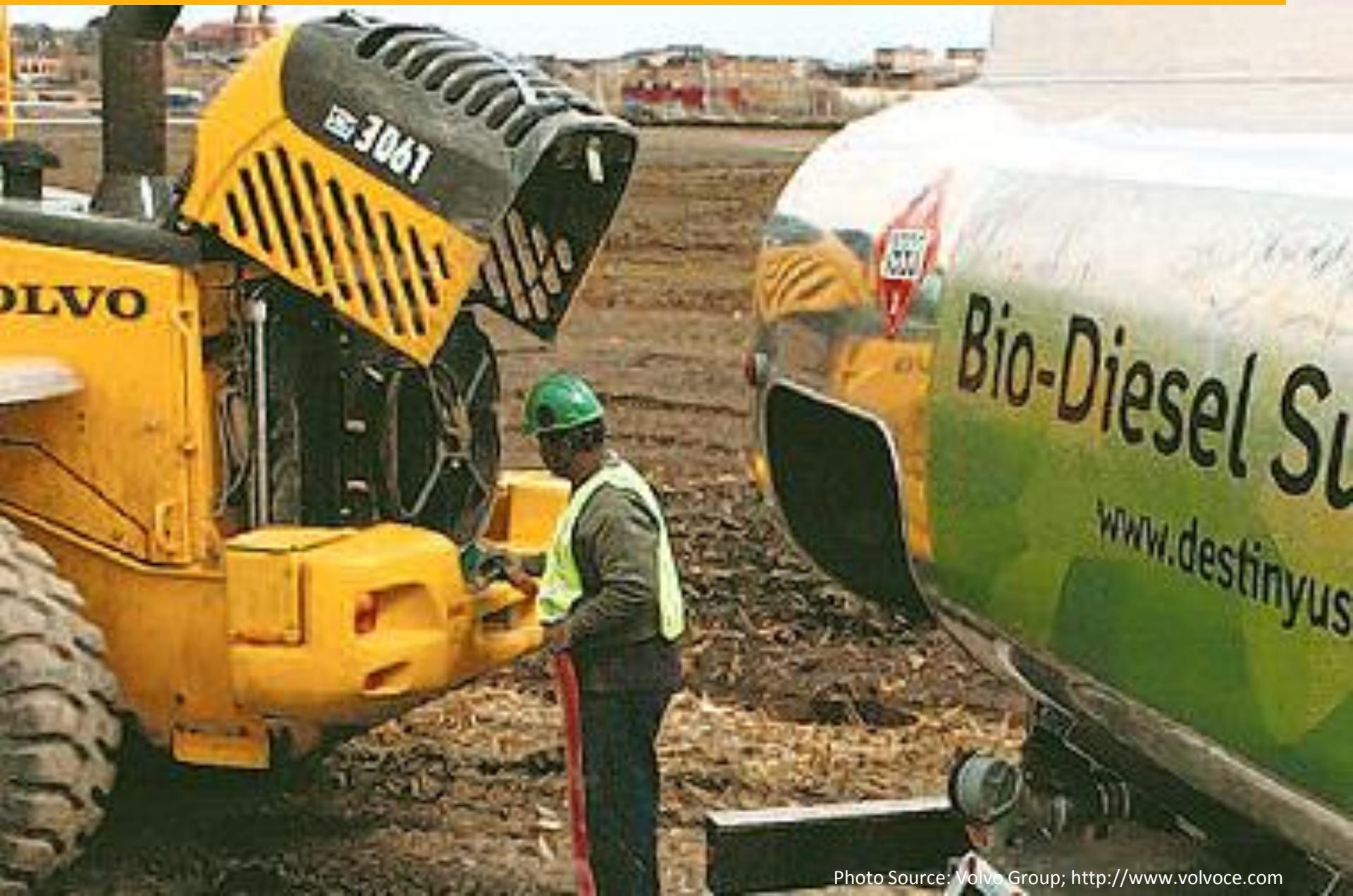


Photo Source: Volvo Group; http://www.volvoce.com

Reduce environmental impacts by utilizing dust control measures at construction site

Sustainable Construction Practices by State

Sustainable Construction Practices	States
Reusing waste in pavement	AR, **AZ**, IN, KS, KY, LA, MA, MI, NV, NC, OK, RI, TX, WA
Restrictions on equipment	IL, MD
Innovative methods to reduce energy	MA, WA
Improving traffic/ transportation system	AL, **AZ**, CA, CO, DC, HI, MD, MN, MO, NV, NH, OR, PA, UT, VT
Recycling / Anti-litter program	**AZ**, IL, KY, MS, OK, WA
Specify requirements for sustainability	AK, FL, HI, ID, MO, NE, NJ, NM, OK, OR, PA, SC, SD, TN, VT, WY
Dust control	**AZ**
Environmental/ reducing emissions	CT, DE, ID, IL, IA, KS, KY, LA, ME, MT, NV, NY, NC, ND, OH, OR, PR, TX, VT, VA, WA, WI, WY
Water & Storm water planning	ID, IL, IA, MS, NV, ND, OH, UT, WV, WI, WY
Special attention to natural habitat	ID, IL, IA, ME, MT, NY, ND, OH, OR, PR, WV, WY

Survey of DOT websites conducted in 2012 by students at Arizona State University

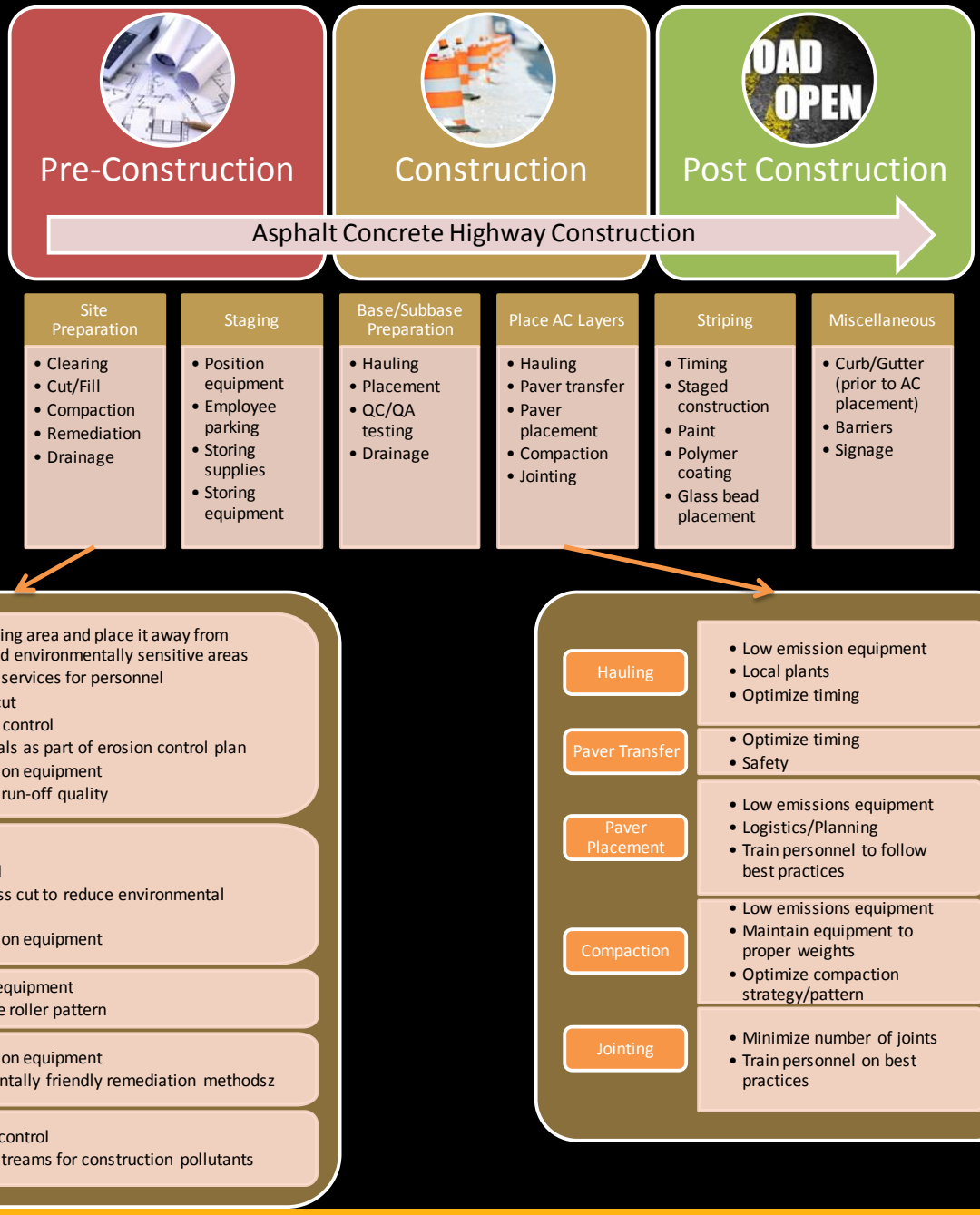
Wrap-up
Take away message

Key Points:

- Sustainability rating systems for highway pavements exist
- Sustainability is context-sensitive
- Developing sustainable construction practices requires local value assessment of social, economic, and ecological goals


Thank You

Example


Pre-Construction
Construction
Post Construction
Asphalt Concrete Highway Construction
Site Preparation
• Clearing
• Cut/Fill
• Compaction
• Remediation
• Drainage
Staging
• Position equipment
• Employee parking
• Storing supplies
• Storing equipment
Base/Subbase Preparation
• Hauling
• Placement
• QC/QA testing
• Drainage
Place AC Layers
• Hauling
• Paver transfer
• Paver placement
• Compaction
• Jointing
Striping
• Timing
• Staged construction
• Paint
• Polymer coating
• Glass bead placement
Miscellaneous
• Curb/Gutter (prior to AC placement)
• Barriers
• Signage
Clearing
• Designate staging area and place it away from populations and environmentally sensitive areas
• Provide transit services for personnel
• Minimize overcut
• Supply erosion control
• Use cut materials as part of erosion control plan
• Use low emission equipment
• Monitor water run-off quality
Cut/Fill
• Balance cut/fill
• Source local fill
• Store any excess cut to reduce environmental contamination
• Use low emission equipment
Compaction
• Low emission equipment
• Establish onsite roller pattern
Remediation
• Use low emission equipment
• Use environmentally friendly remediation methodsz
Drainage
• Install erosion control
• Monitor local streams for construction pollutants
Hauling
• Low emission equipment
• Local plants
• Optimize timing
Paver Transfer
• Optimize timing
• Safety
Paver Placement
• Low emissions equipment
• Logistics/Planning
• Train personnel to follow best practices
Compaction
• Low emissions equipment
• Maintain equipment to proper weights
• Optimize compaction strategy/pattern
Jointing
• Minimize number of joints
• Train personnel on best practices