ASPHALT:

the environmentally sustainable pavement

Greening the Blacktop

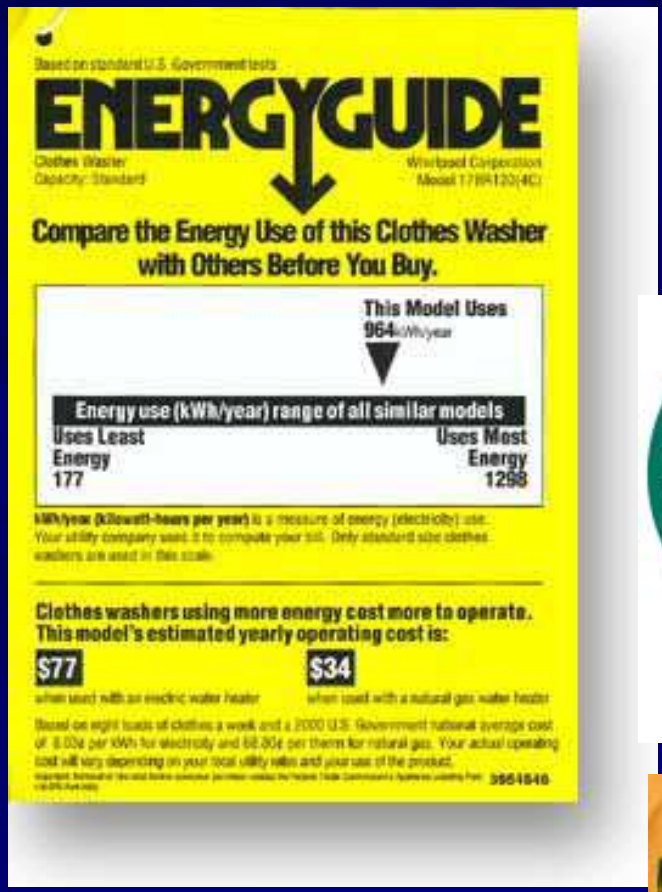
NAPA

ASPHALT:

the environmentally sustainable pavement

- Background information
- Stormwater management / porous pavement
- UHI and reflective asphalt pavements
- USGBC LEED
- Recycled materials / RAP
- Env. Impacts and Carbon Footprints
- Warm Mix Asphalt

. . . what is it ?



environmental sustainability

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. . . what is it ?

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SGBC is a community of leaders working to transform the way buildings and ommunities are designed, built and operated. We envision an environmentally sponsible, healthy, and prosperous environment that improves the quality of life.

What is LEED?

The LEED Green Building Rating System is the national benchmark for high performance green buildings. Learn More.

PIC

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News

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n Building 101

What's New

Former President Bill Clinton to Keynote Opening Plenary of Greenbuild

Clinton's keynote will kick off what is expected to be the largest Greenbuild ever. Read More...

LEED for High Performance Operations Second Public Comment Period Now Open

Please weigh in on changes made since the first public comment period. Read More...

Call for Nominations for the 2007 Chapter Awards

Awards recognize outstanding chapter achievements in Advocacy, Education, Research, LEED, USGBC as a Community, and Organizational Excellence. Read More...

USGBC featured in THE 11th HOUR

environmental sustainability

NAPA

ASPHALT

The Sustainable Pavement

ENERGY & RECYCLING

PERFORMANCE

WATER QUALITY

CLEAN AIR & COOL CITIES

Asphalt is the sustainable material for constructing pavements.

From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction.

www.pavegreen.com

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ASPHALT *The Sustainable Pavement*

ENERGY & RECYCLING | PERFORMANCE | WATER QUALITY | CLEAN AIR & COOL CITIES

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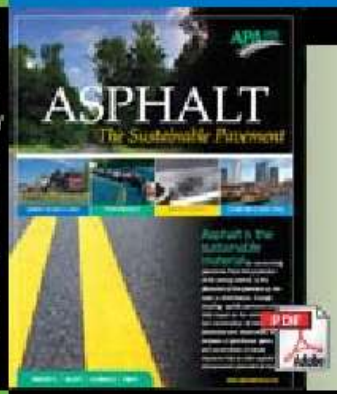


Asphalt is the sustainable material for constructing pavements. From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction, low emission of greenhouse gases, and conservation of natural resources help to make asphalt the environmental pavement of choice.

Energy and Recycling

Less energy consumed in building pavements

Asphalt pavements require about 20 percent less energy to produce and construct than other pavements.[1]

Less energy consumed by the traveling public

Congestion leads to unnecessary consumption of fuel and production of emissions. Reducing congestion by constructing asphalt pavements just makes sense. Asphalt pavements are faster to construct and rehabilitate. And, a new or newly rehabilitated asphalt pavement can be opened to traffic as soon as it has been compacted and cooled. There is no question of waiting for days or weeks for the material to cure.

America's leading recycler

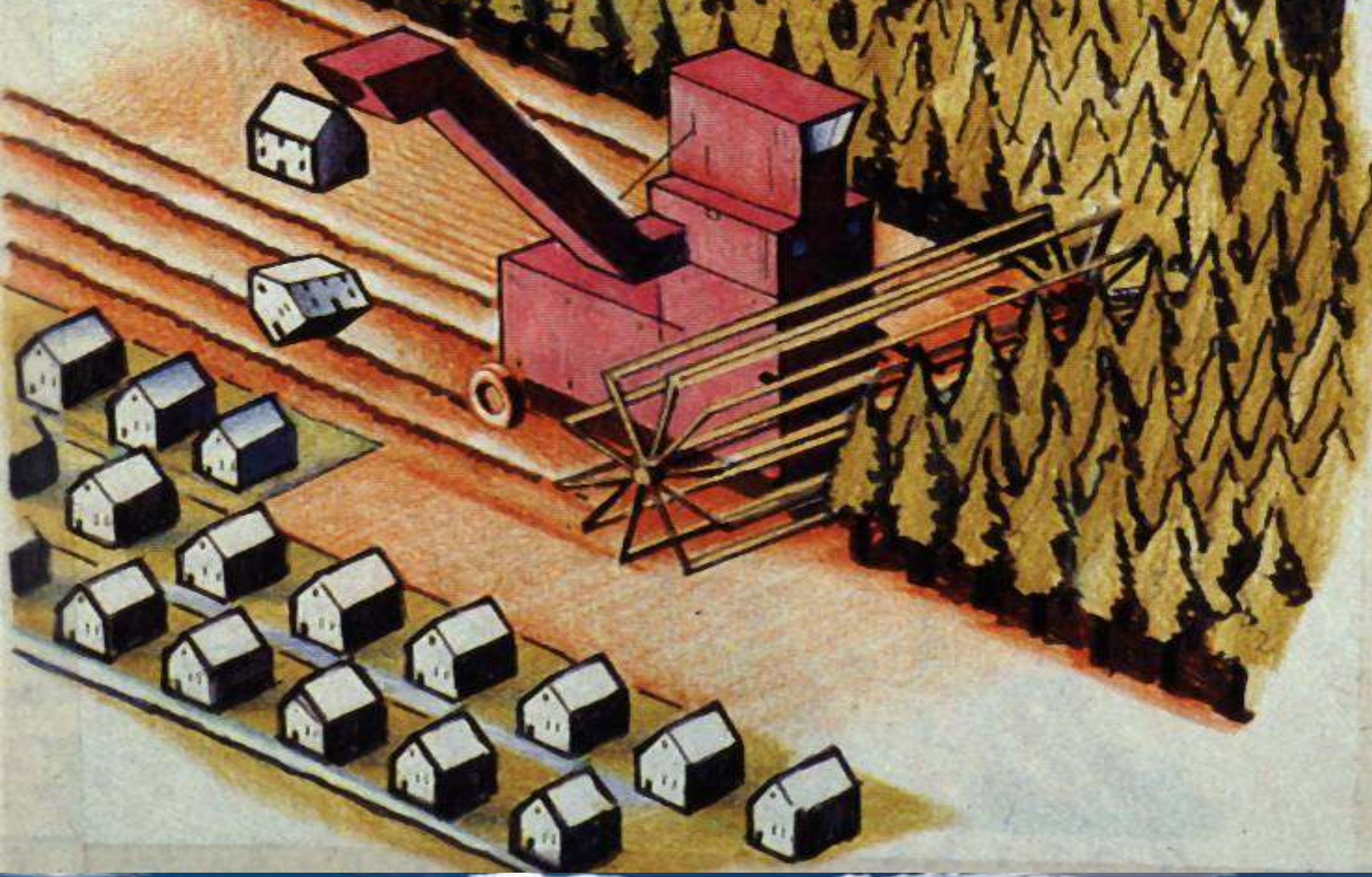
According to an EPA/FHWA study,[2] the asphalt industry recycles more than 70 million tons of its own product every year, making it America's number one recycler. Asphalt recycling saves taxpayers about $1.8 billion a year.

Other materials are routinely recycled into asphalt pavements. Some of the most common are rubber from used tires, glass, asphalt roofing shingles, and blast furnace slag.

Performance

The road doesn't wear out

Asphalt is the Perpetual Pavement. When appropriately designed and constructed, the road itself doesn't



urban development

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urban development
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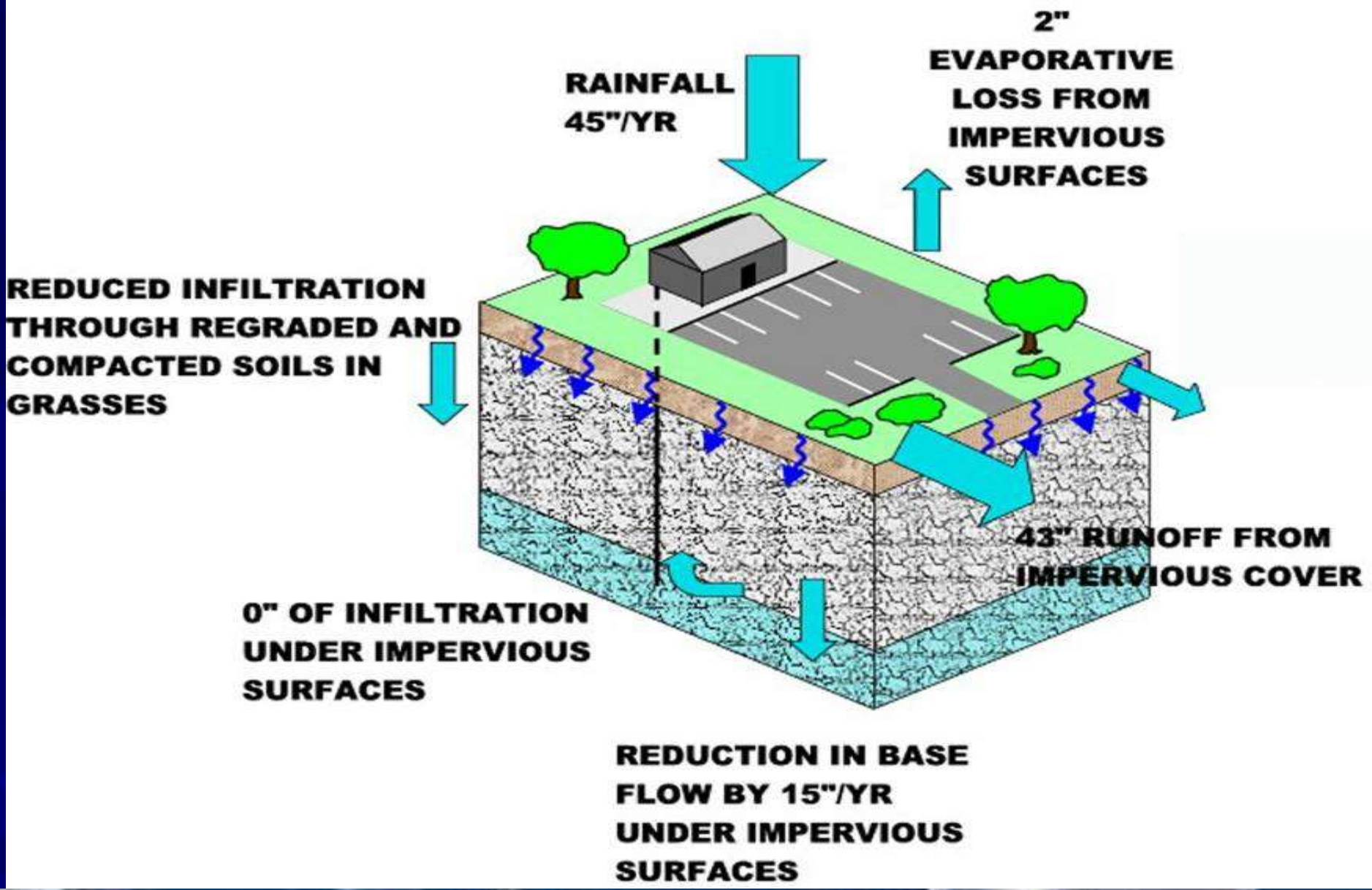
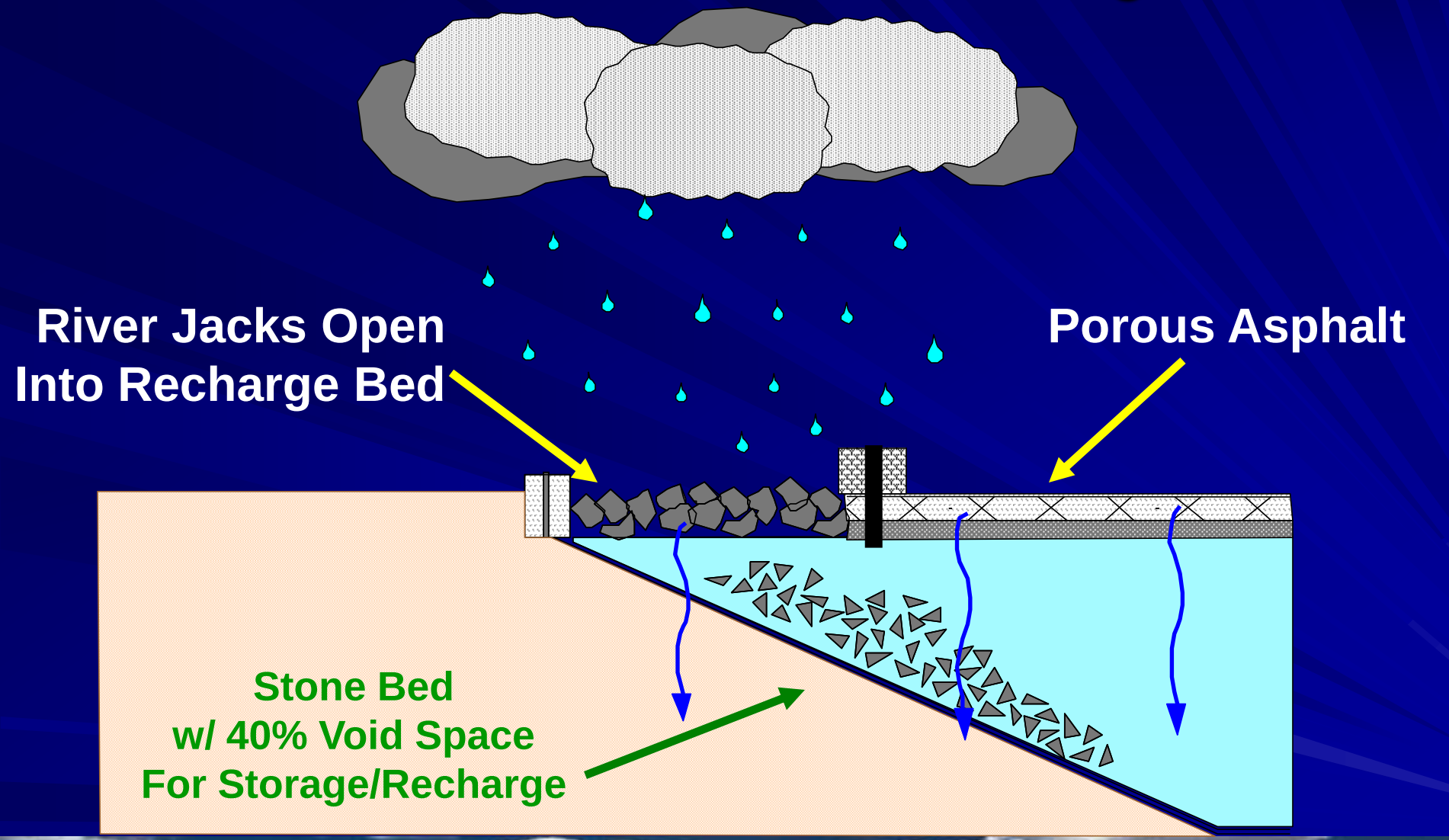
stormwater management
NAPA


2"
EVAPORATIVE
LOSS FROM
IMPERVIOUS
SURFACES
RAINFALL
45"/YR
REDUCED INFILTRATION
THROUGH REGRADED AND
COMPACTED SOILS IN
GRASSES
43" RUNOFF FROM
IMPERVIOUS COVER
0" OF INFILTRATION
UNDER IMPERVIOUS
SURFACES
REDUCTION IN BASE
FLOW BY 15"/YR
UNDER IMPERVIOUS
SURFACES

Porous Pavement with Recharge Bed




stormwater management
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Univ. NC: add'l parking lot constructed ca. 2002

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Pringle Creek COMMUNITY

LET'S BUILD A PLACE...

OVERVIEW | PRINCIPLES | COMMUNITY | LOCATION | RESOURCES | CONTACT

WHAT IS A GREEN STREET?

The streets at Pringle Creek Community are part of an integrated water infiltration system that captures, absorbs and filters stormwater instead of sending it downstream in pipes. If the first one inch of every rainfall is captured and absorbed, 90% of rainwater is prevented from entering stormwater pipes.

Read More >

View Street Diagram >

Taxes on impervious residential surfaces – Iowa . . . and more states to come

porous streets !!

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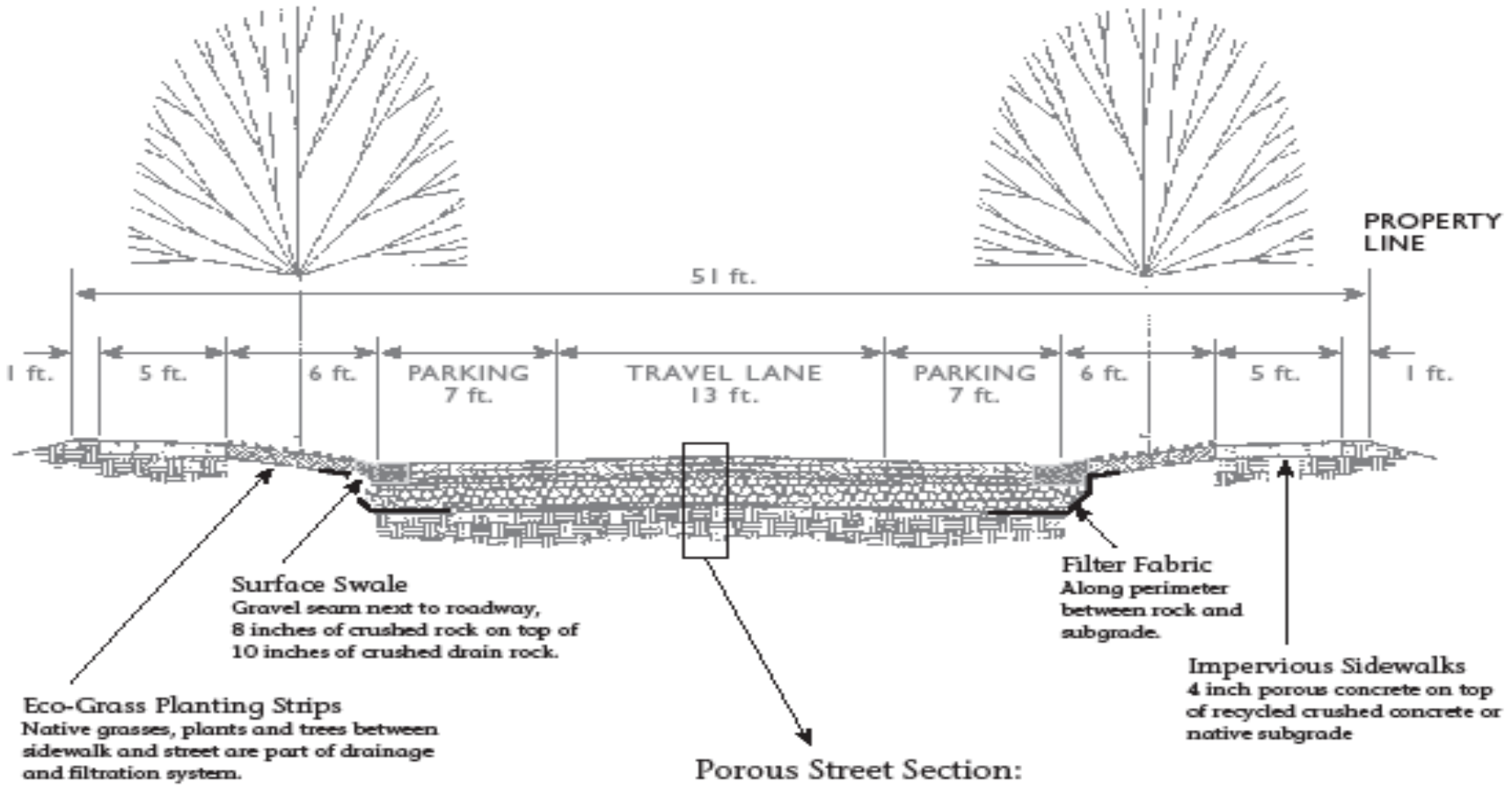
WHAT IS A GREEN STREET?



porous streets !!

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Benefits of Porous Pavement

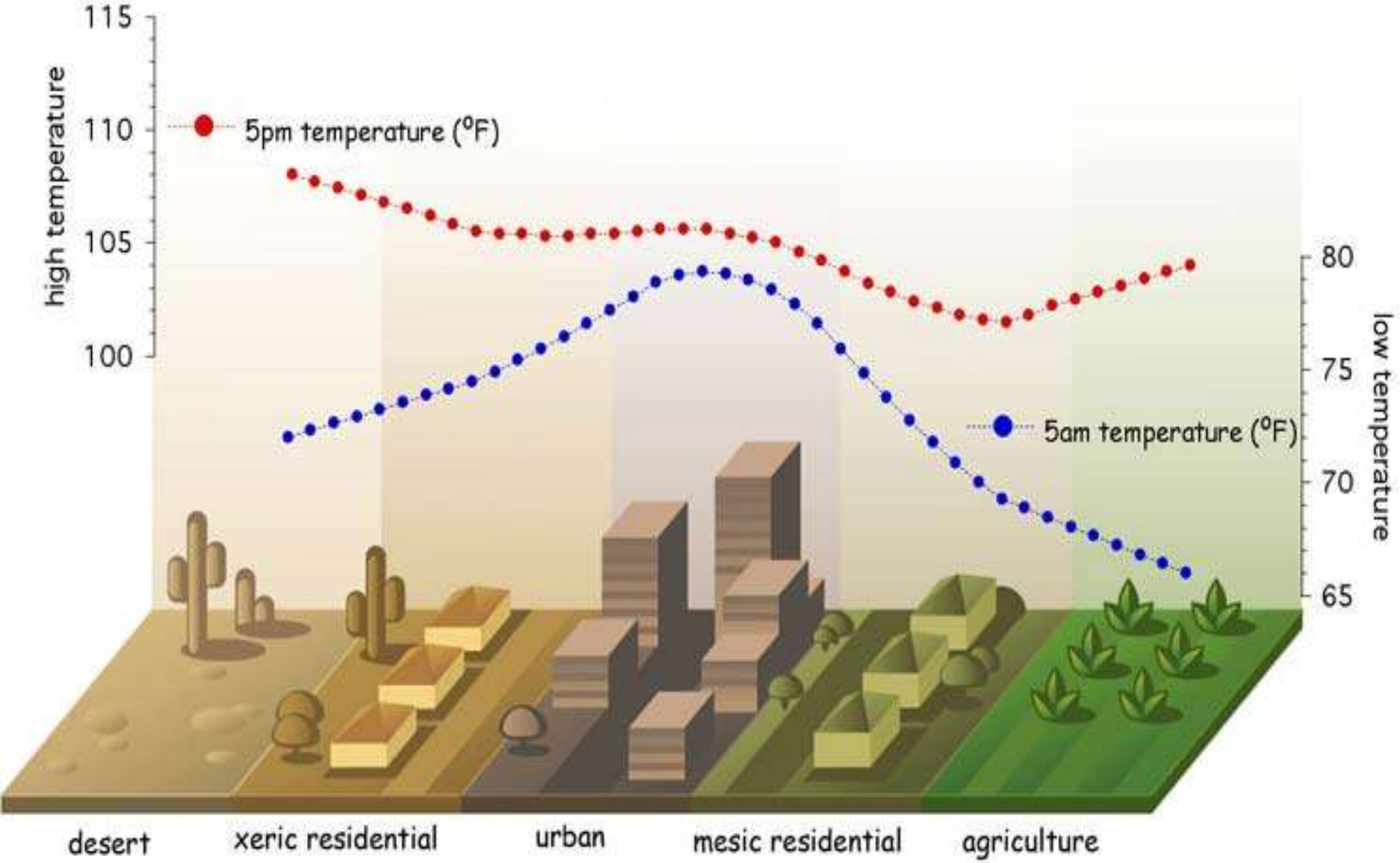
- **Economic**
  - Reduces/Eliminates the land space consumed by conventional detention facilities
  - Helps prevent excessive flooding and minimizes need for control measures
- **Aesthetic**
  - Eliminates the need for unsightly detention basins
  - Preserves areas such as woods/open space
- **Environmental**
  - Limits peak stormwater discharge and improves water quality of any runoff
  - Reduces amount of impervious surfaces

- Dense-graded asphalt pavements were historically the standard for roadways
  - Provides structure, strength, and smoothness
  - Smoothness can cause water overspray
- Open-graded Friction Courses (OGFC) developed to minimize overspray
  - Developed in the late 1940s (airports)
  - Pavement contains greater air voids
  - Thin OGFC pavement above dense-graded mat
- OGFC Highly successful in minimizing accidents
  - Calif-DOT identified a 50% decrease in deaths and 20% decrease in accidents after Hwy re-paved using OGFC
  - Other state statistics similar

Spray Reduction: OGFC on Freeway

- Vehicles on highways generate a significant amount of noise
- Noise from the tire/pavement interface accounts for over 75% of the vehicle noise
- Sound-walls are expensive and are only somewhat effective if placed in the line-of-sight
  - They reduce noise minimally and only over certain distances from the roadway
  - Sound-walls can increase UHI effects because they decrease air movement across pavement surface
- Traffic Noise can be significantly reduced using Open-Graded Friction Courses (OGFC)

Noise Reduction: AR-OGFC on Highway



Urban Heat Islands

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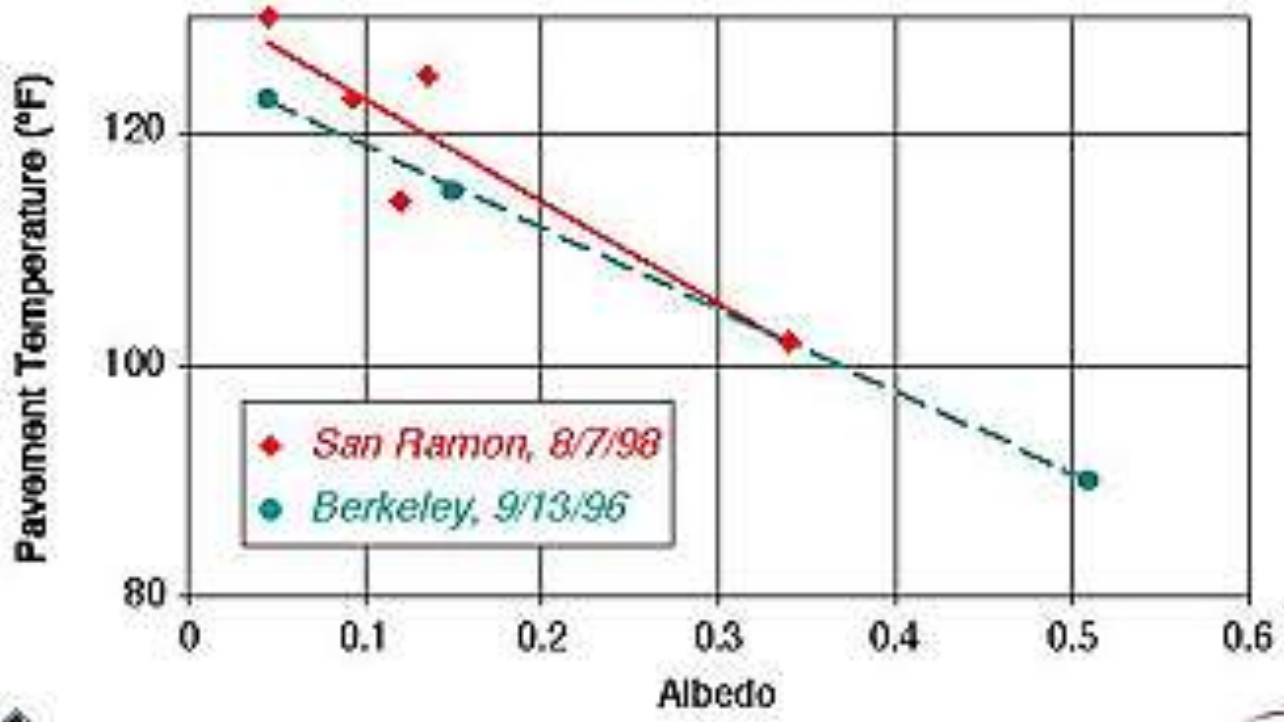
Pavement Temperatures *vs.* Albedos



myth or reality ?

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Location: University Dr., Tempe, AZ
Time: 2:30pm, May 15, 2007

Albedo = .192
Surf. Temp = 131, 131.5, 130 (°F)
Age = >5 years
Traffic = light foot, cart and bicycle traffic

Albedo = .090
Surf. Temp = 129.9, 130.2, 128.4 (°F)
Age = >5 years
Traffic = constant traffic

Albedo = .036
Surf. Temp = 146.8, 143.3, 147.4 (°F)
Age = 3 days
Traffic = no traffic

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reflectivity & temperatures

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Cooler Pavements→Cooler Air

Los Angeles: Simulate change of all pavement albedos (in < 20 years of normal maintenance)

- ***Input:***

Albedo change =	**0.25**
Pavement area =	1,250 km²
Urban area =	10,000 km²

Normal LA weather

- ***Result:***

—*Decrease in air temperature ≅ 0.6°C (1°F)*

why is this important ?

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cooler pavements

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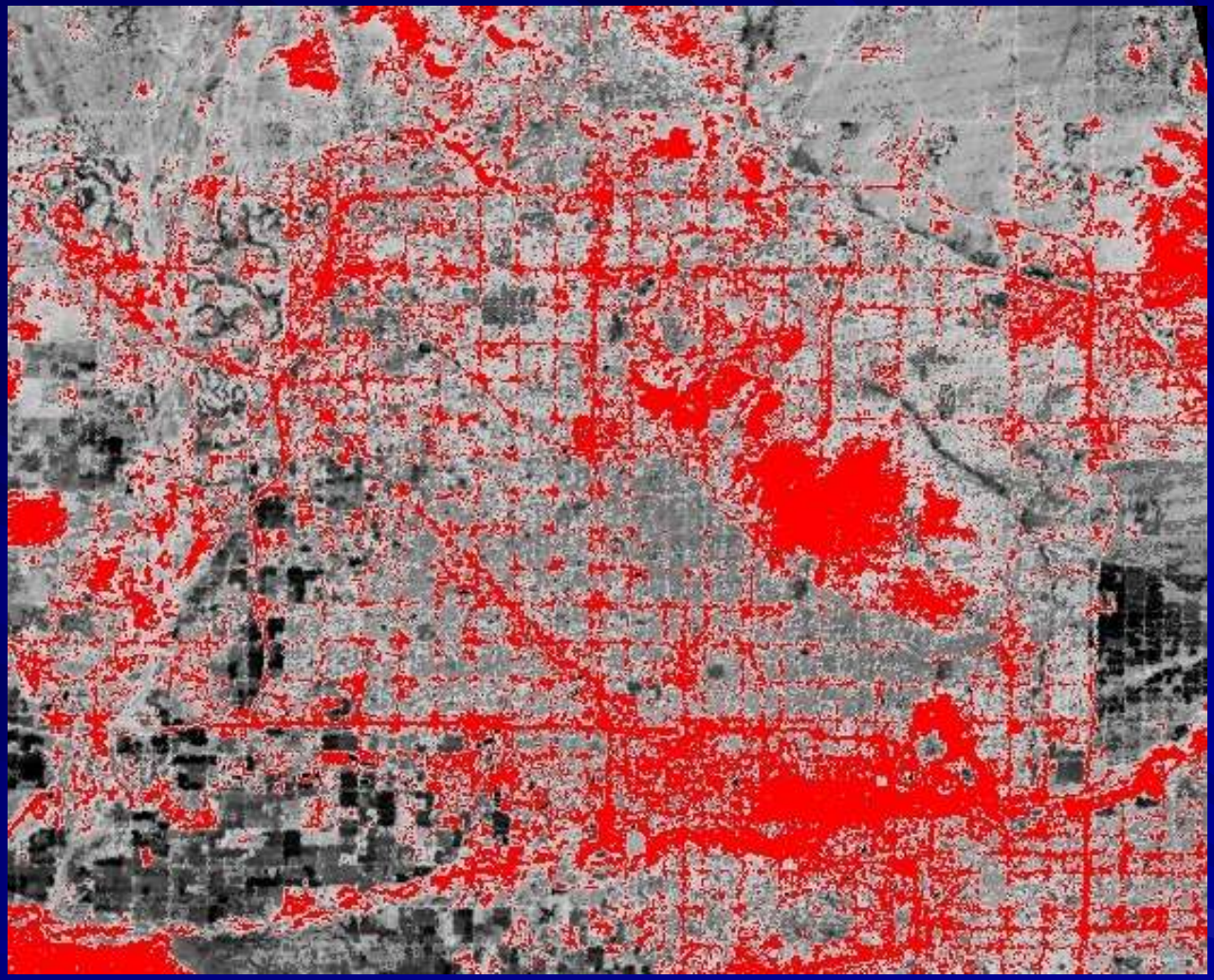

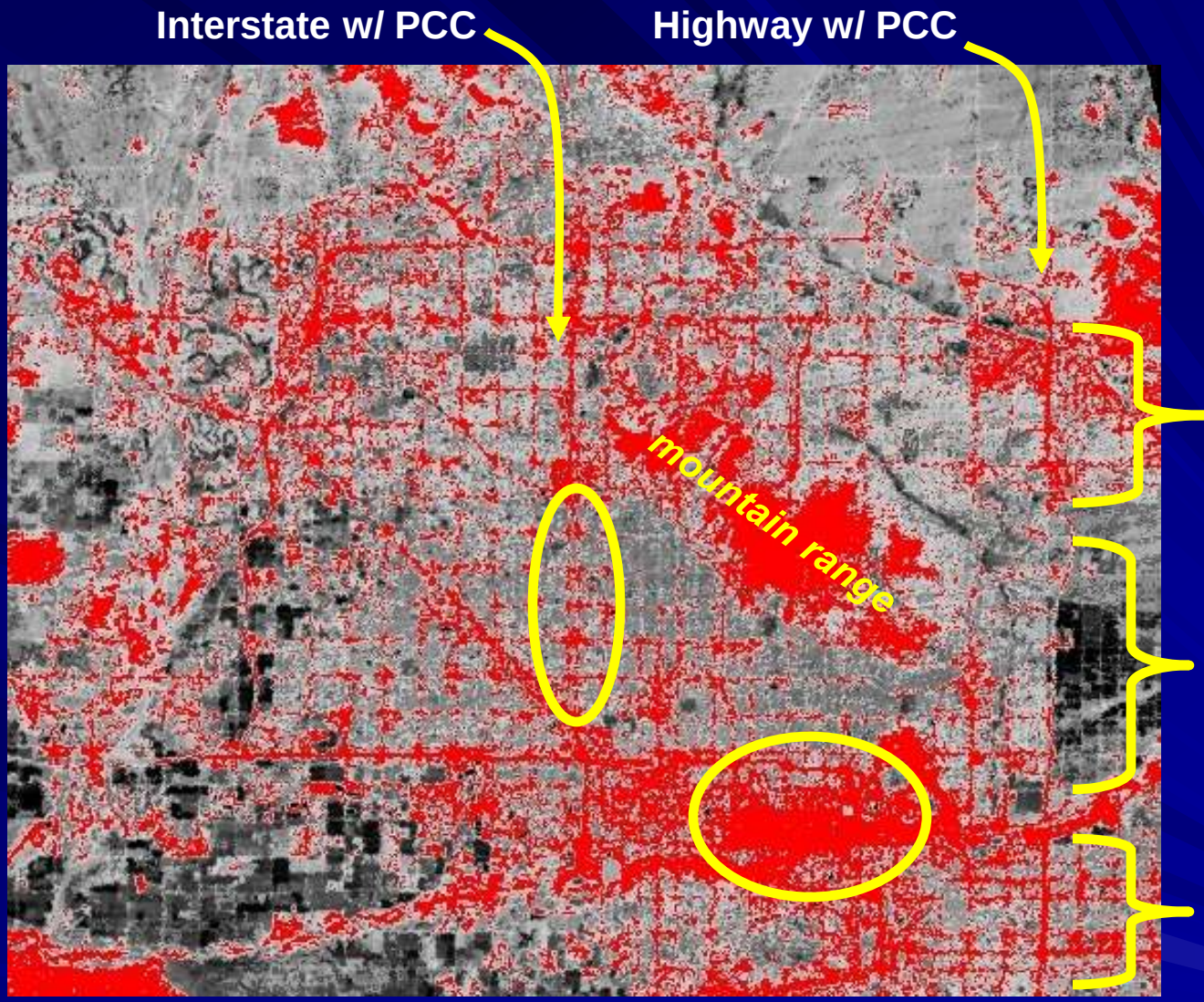

cooler pavements

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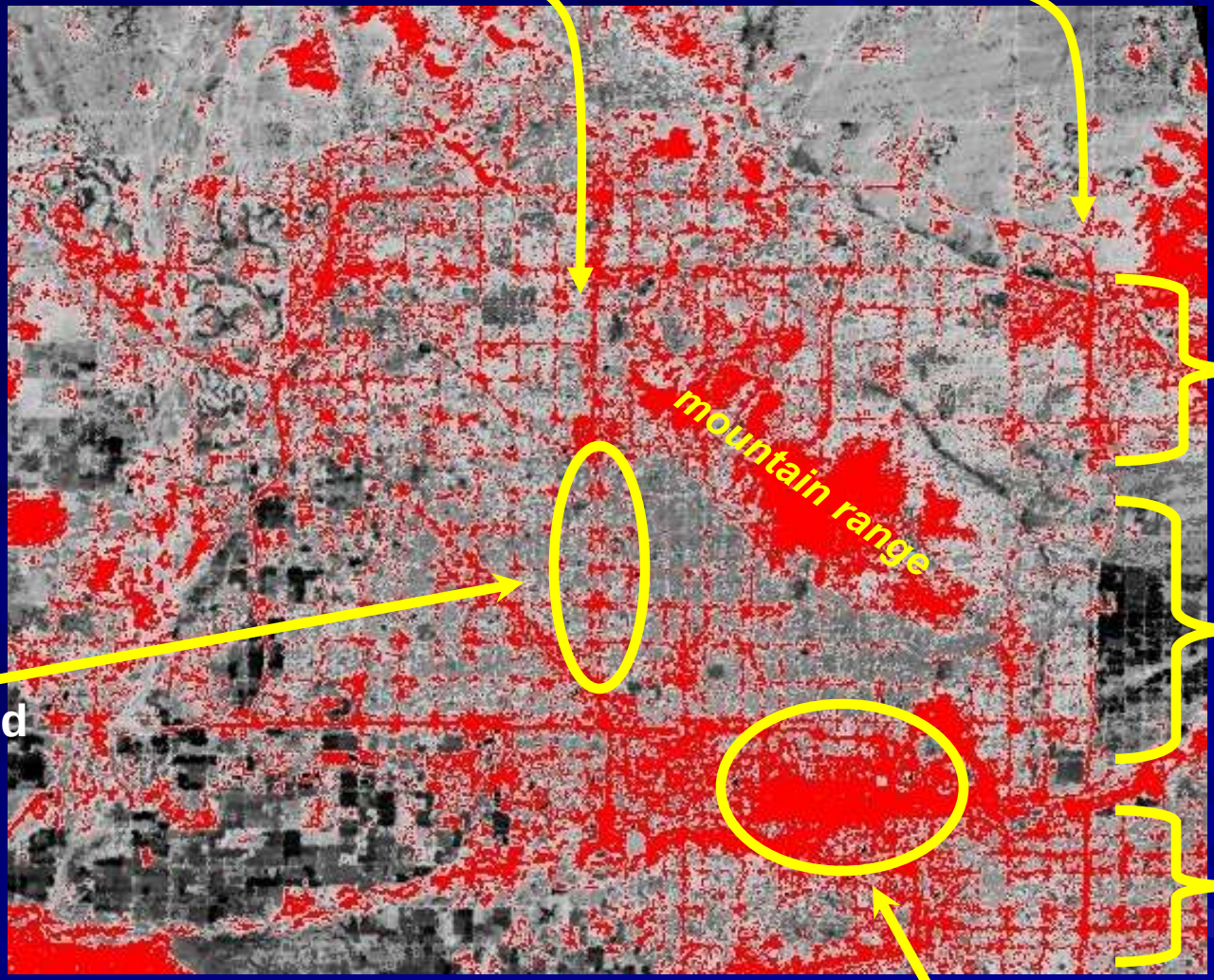

cooler pavements

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Heat Island Effect

Cool Pavements

■ - Denotes link to glossary definition

There is no official standard or labeling p
early stage.

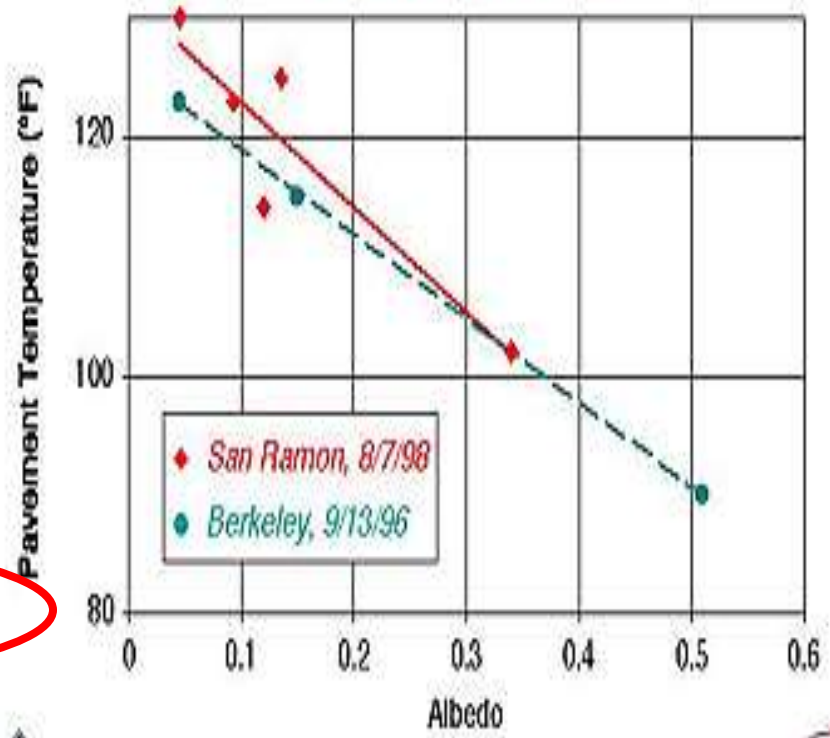
While studies show that pavements can a
several factors. These include the impact
time; and the absorption by buildings of s

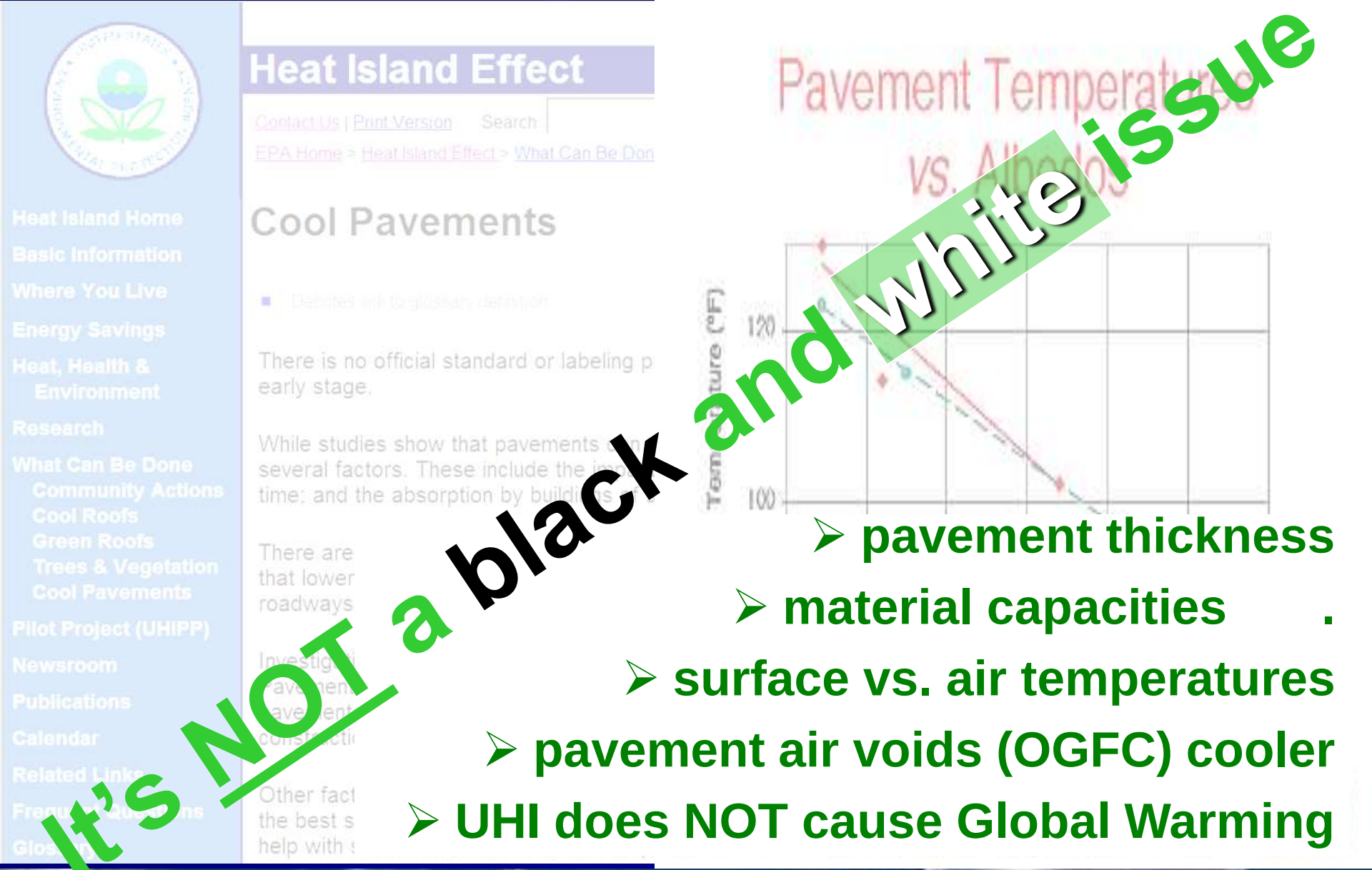
There are situations, however, where cor
that lower surface temperature and achie
roadways with large expanses of paved s

Investigations of cool paving materials ha
Pavements with higher solar reflectance■
pavements benefit from the cooling effec
construction are essential in applying eith

Other factors affecting performance, cos
the best solutions may occur where multi
help with storm water runoff as well as p

Pavement Temperatures vs. Albedos

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Where You Live
Energy Savings
Heat, Health & Environment
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What Can Be Done
Community Actions
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Green Roofs
Trees & Vegetation
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Pavement Temperatures vs. Albedo
Temperature (°F)
120
100
It's NOT a black and white issue
➢ pavement thickness
➢ material capacities .
➢ surface vs. air temperatures
➢ pavement air voids (OGFC) cooler
➢ UHI does NOT cause Global Warming
NAPA

Surface Chip Seals and Coatings:
using reflective / light-colored chip / paints

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“Gritting”:
reflective chips and aggregate

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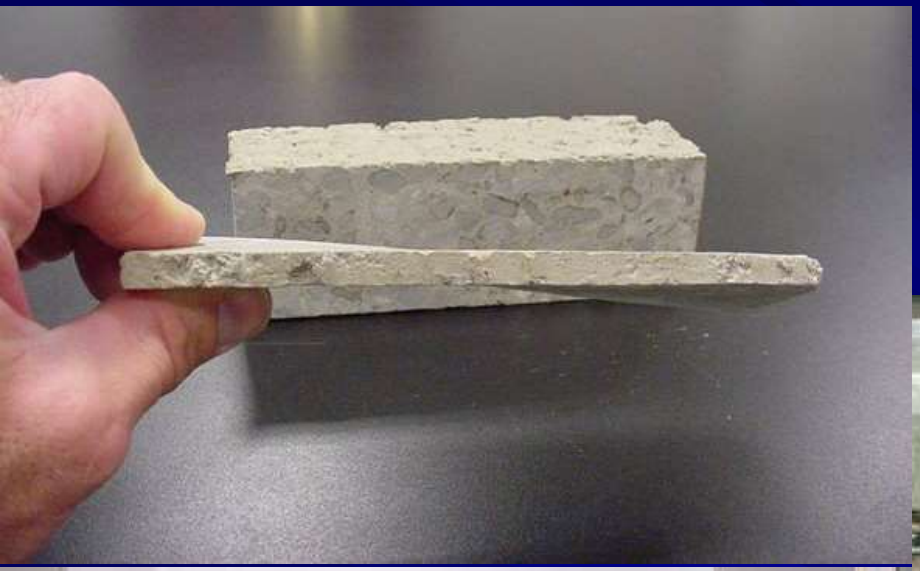
Shot-Blasting:
abrading surface binder

Synthetic and Colored Binders:
using reflective aggregates



reflective pavements

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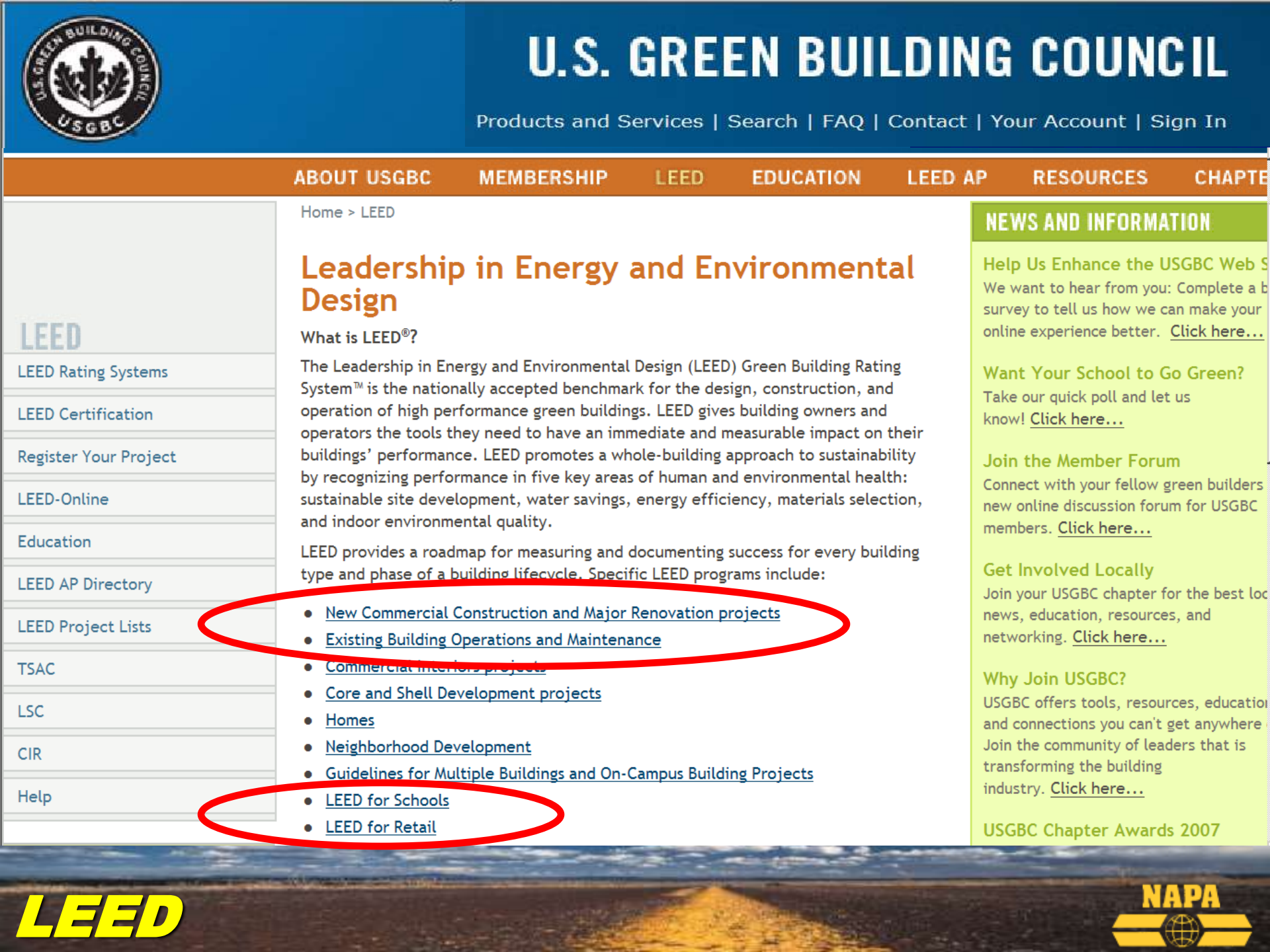
Synthetic / Colored Binders:
using reflective / colored aggregates

Using Asphalt Pavement to Reduce UHI

- Albedo doesn't appear to be the entire story
- The role of thickness, density, and porosity are being evaluated to understand pavement's heat sink capacity
- Other "BMPs" have been identified to help mitigate pavement surface temperature (trees, topography)
- OGFC / porous pavements have been shown to be highly effective in reducing pavement surface temps
- Reflective HMA pavements can be produced $$
- But . . . IMHO . . .
- Pavement design has "net zero" balance on UHI temps
- USGBC needs to understand this . . .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Leadership in Energy and Environmental Design
What is LEED®?
The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.
LEED provides a roadmap for measuring and documenting success for every building type and phase of a building lifecycle. Specific LEED programs include:
New Commercial Construction and Major Renovation projects
Existing Building Operations and Maintenance
Commercial Interiors projects
Core and Shell Development projects
Homes
Neighborhood Development
Guidelines for Multiple Buildings and On-Campus Building Projects
LEED for Schools
LEED for Retail
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Take our quick poll and let us know! Click here...
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LEED: Leadership in Energy and Environmental Design

- Developed by USGBC
- National benchmark for design, construction, and operation of “green” buildings
- 5 key areas:
  - Sustainable site development
  - Water savings
  - Energy efficiency
  - Materials selection
  - Indoor environmental quality
- Earning LEED certification
  - Must meet certain criteria → credits / certification process
  - Levels based on total credits
- How asphalt pavements contribute to LEED credits

Retail Certification Levels

Certified: 26-32 points

Silver: 33-38 points

Gold: 39-51 points

Platinum: 52-70 points

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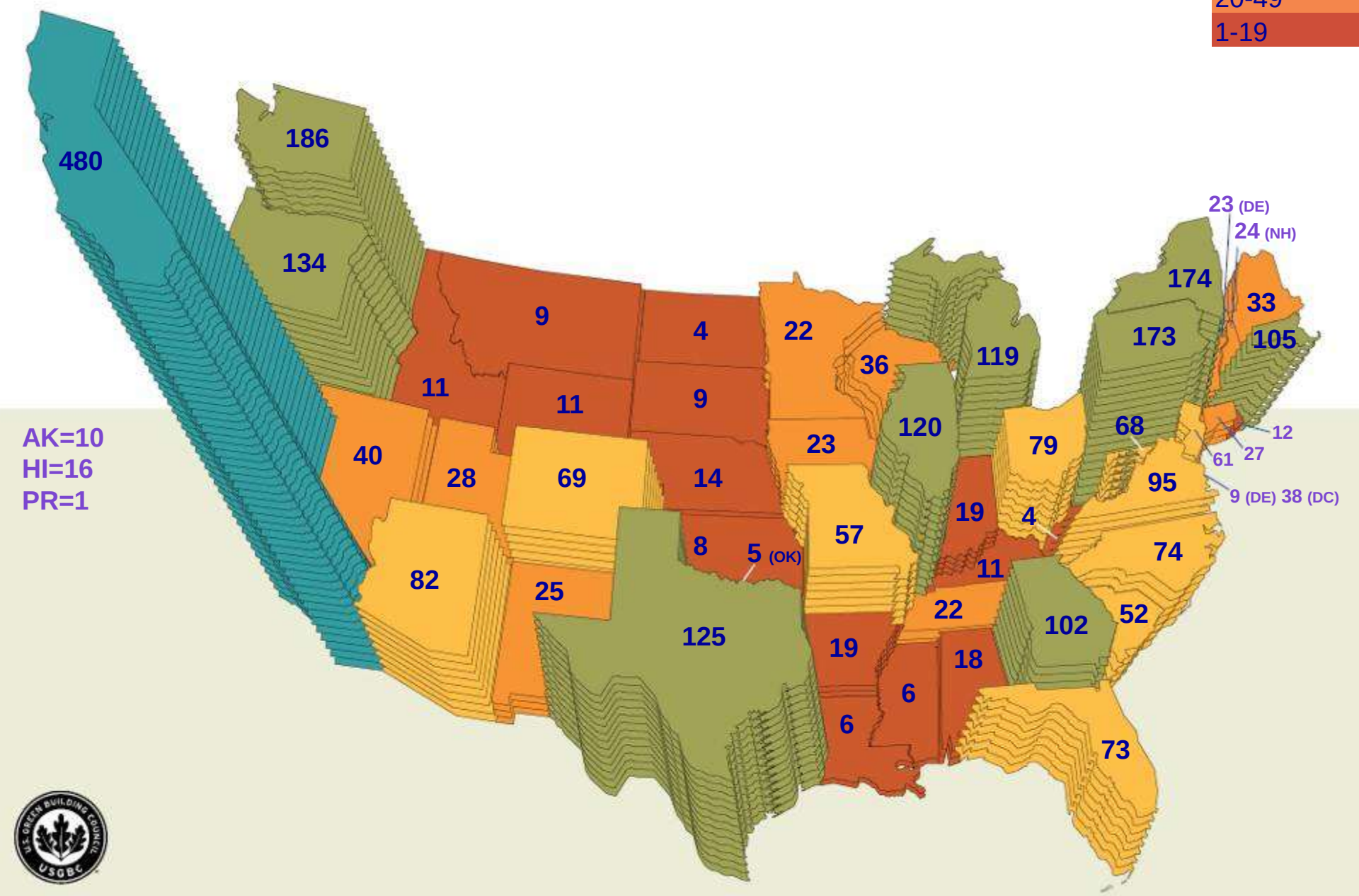
Distribution by geography

as of 07/06



Green Building Rating System

LEED for Retail - New Construction and Major Renovations

Retail Certification Levels

Certified: 26-32 points

Silver: 33-38 points

Gold: 39-51 points

Platinum: 52-70 points

Category	Possible Points
Sustainable Sites:	16
Water Efficiency:	5
Materials & Resources:	13
Energy & Atmosphere:	17
Indoor Environ. Quality:	14
Innovation & Design:	5

LEED process

NAPA

Sustainable Sites — 16 Possible Points

Prereq 1	**Construction Activity Pollution Prevention**	Required
Credit 1	**Site Selection**	1
Credit 2	**Development Density & Community Connectivity**	1
Credit 3	**Brownfield Redevelopment**	1
Credit 4	**Alternative Transportation** A. Public Transportation Access (1 point) B. Bicycle Storage & Commuting (1 Point) C. Low Emitting & Fuel Efficient Vehicles (1 Point) D. Parking Capacity (1 Point) E. Delivery Service (1 Point) F. Incentives (1 Point) G. Car-Share Membership (1 Point) H. Alternative Transportation Education (1 Point)	4
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**, Non-Roof	1
Credit 7.3	**Heat Island Effect**, Non-Roof	1
Credit 7.4	**Heat Island Effect,** Roof	1
Credit 8	**Light Pollution Reduction**	1

5 credits

LEED credit for asphalt

NAPA

Materials & Resources — 13 Possible Points

Prereq 1	**Storage & Collection of Recyclables**	Required
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls, Floors & Roof	1
Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
Credit 3.1	**Materials Reuse**, 5%	1
Credit 3.2	**Materials Reuse**, 10%	1
Credit 4.1	**Recycled Content**, 10% (post-consumer + 1/2 pre-consumer)	1
Credit 4.2	**Recycled Content**, 20% (post-consumer + 1/2 pre-consumer)	1
Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regionally	1
Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regionally	1
Credit 6	**Rapidly Renewable Materials**	1
Credit 7	**Certified Wood**	1

Reuse up to 10%
Recycled up to 20%

8 credits

Green Building Rating System
LEED for Retail - New Construction and Major Renovations

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Sustainable Sites:	16
Water Efficiency:	5
Materials & Resources:	13
Energy & Atmosphere:	17
Indoor Environ. Quality:	14
Innovation & Design:	5

from asphalt

5
+
8
—
13

Reuse up to 10%
Recycled up to 20%

LEED process

NAPA

Asphalt pavement is positioned nicely

- Recycled (re-used) and recyclable
  - Innovation credit every 5% more than 10% / 20% reused / recycled – petition USGBC LEED
- Local materials
- Stormwater management
- UHI: need to work through the “process”
  - Comfort issue under limited circumstances
  - Porous pvmts / OGFC might mitigate – petition
  - Asphalt reflective pavements can be produced


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ASPHALT
The Nation's # 1 Recycled Material
recycled pavement
NAPA

Common Recycled Materials in Asphalt Pavements

- Shingles
- Crumb / Tire Rubber
- Glass
- Slag
- Foundry sand
- All are in different stages of utilization / evaluation

asphalt shingles

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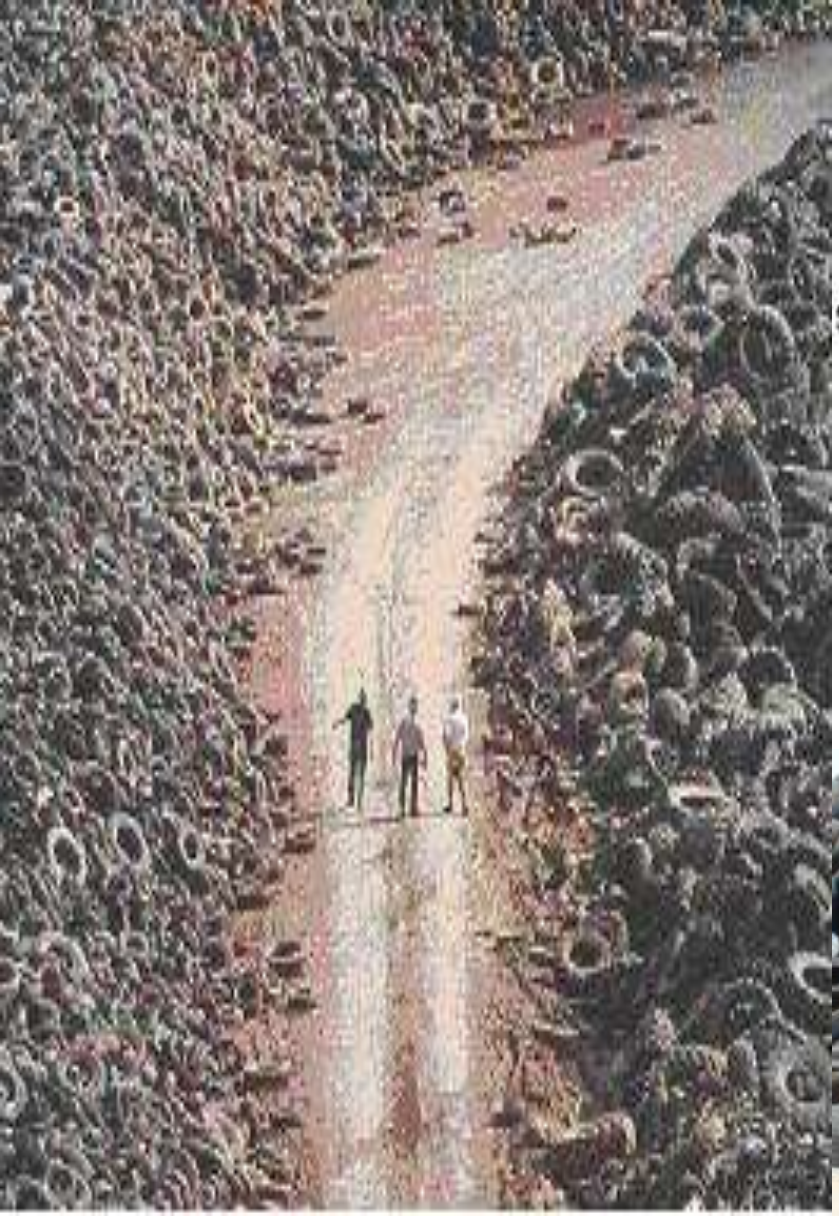

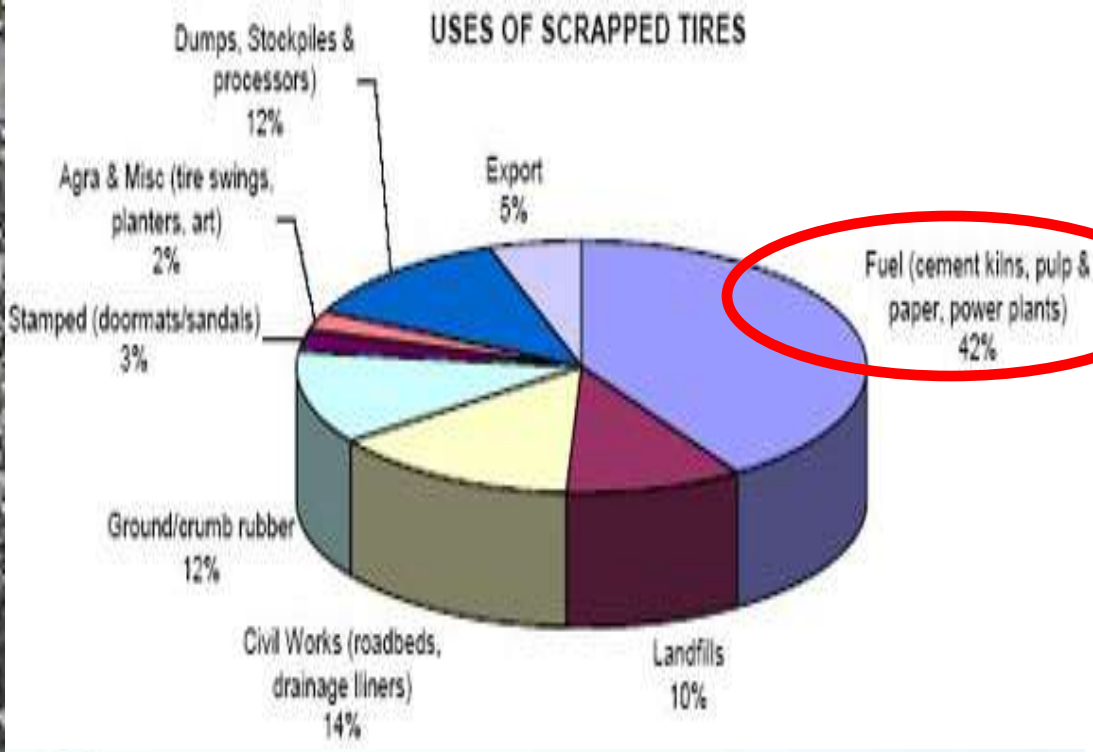
USES OF SCRAPPED TIRES
Dumps, Stockpiles & processors) 12%
Agra & Misc (tire swings, planters, art) 2%
Stamped (doormats/sandals) 3%
Export 5%
Fuel (cement kilns, pulp & paper, power plants) 42%
Ground/crumb rubber 12%
Civil Works (roadbeds, drainage liners) 14%
Landfills 10%


scrap tires
NAPA

milling asphalt pavement

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reclaimed asphalt pavement "RAP"

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sizing RAP

NAPA

sizing RAP

NAPA

processing RAP

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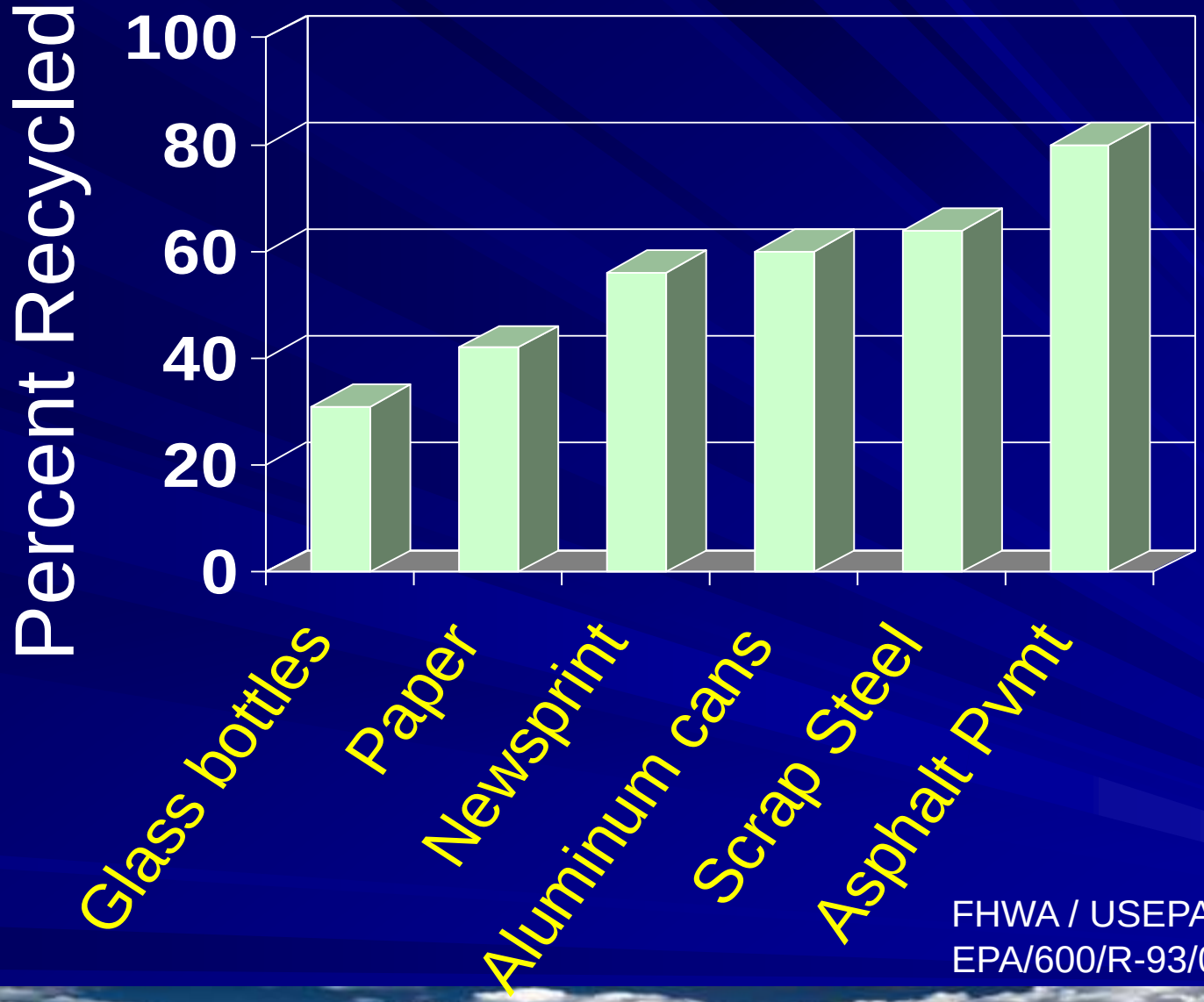
Reclaimed Asphalt Pavement "RAP"

- Removed and/or reprocessed pavement materials containing asphalt and aggregates
- Over 80 percent of the asphalt pavement, removed each year for widening and resurfacing, is re-used
- Represents close to 100 million tons / year
- RAP is the Nation's No. 1 recycled material in both total amount and percentage recycled



FHWA / USEPA Report to Congress, EPA/600/R-93/095.

recycled pavement

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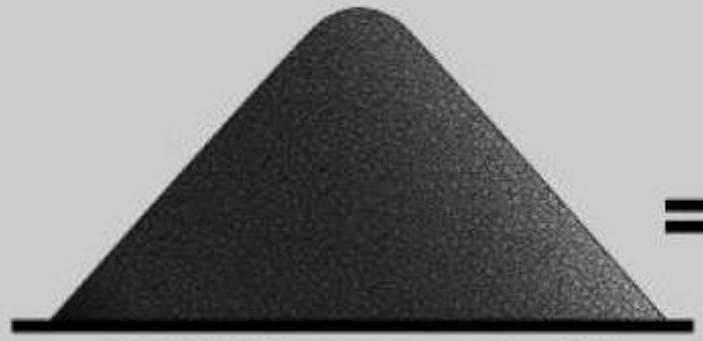


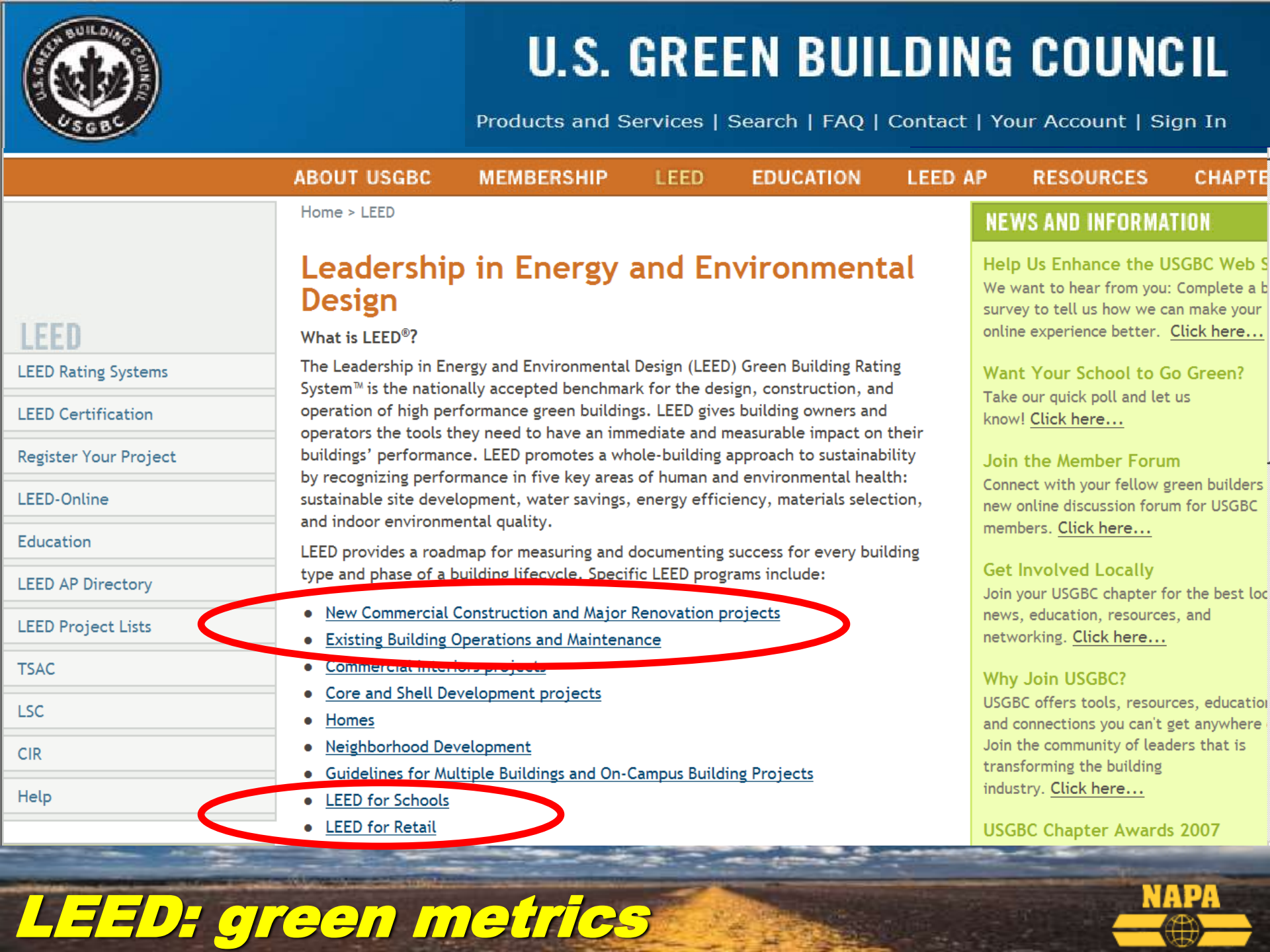
30,000 Tons of RAP

=

70 - 6,000 Gallon Transport Trailers
and 28,200 Tons of Clean Aggregate

RAP: sustainable & carbon neutral

NAPA



LEED: green metrics

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Sustainable and environmentally sound roads for our future

What is Green Roads? edit

Green Roads, is a rating system that distinguishes high-performance sustainable new, reconstructed or rehabilitated roads. It awards credits for approved sustainable or environmentally friendly choices/practices and can be used to certify projects based on total point value. more...

Why? Assessment & Information edit

Green Roads provides (1) a quantitative means to assess the sustainability and enviornmental stewardship of roads, and (2) a tool for decision-makers that allows them to make informed design and construction decisions regarding sustainability and envirnmental stewardship of a road.

Green Highways Partnership

Stewardship, Safety, & Sustainability

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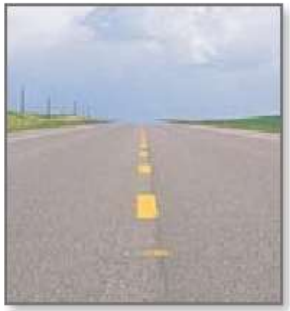


The Partnership

The Green Highways Partnership (GHP) is a voluntary, public/private initiative that is revolutionizing our nation's transportation infrastructure. Through concepts such as **integrated planning**, **regulatory flexibility**, and **market-based rewards**, GHP seeks to incorporate environmental **streamlining and stewardship** into all aspects of the highway lifecycle.

With an extensive network of environmental, industrial and governmental collaborators, GHP believes active cooperation and regulatory progressiveness are critical in moving beyond the current paradigm. The combined resources of our partner base allow Green Highways to ensure that sustainability becomes the driving force behind infrastructure development. By harnessing the power of the

Spotlight

GHPodcast

New GHPodcasts feature the latest GHP developments.

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ACPA Award

EPA's Dominique Lueckenhoff, first recipient of Outstanding Health, Safety & Environmental Stewardship Award.

READ »

What's New?

- **GHP Reuse/Rec Workshop**

  The GHP Aug. 2 recycling works goes off without hitch.

- **Strategic Conservation Planning Course Shepherdstown**

  The Conservatio is offering a Str Conservation Pl course in Shepherdstown, from October 15

other green metric programs

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BEES® 4.0

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What's the Buzz?
BEES for USDA

The BEES (**B**uilding for **E**nvironmental and **E**conomic **S**ustainability) software brings to your fingertips a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the NIST (National Institute of Standards and Technology) Building and Fire Research Laboratory the tool is based on consensus standards and designed to be practical, flexible, and transparent. Version 4.0 of the Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 230 building products.

In support of the 2002 Farm Security and Rural Investment Act (P.L. 107-171), BEES has been adapted for application to biobased products. For more information about this program, go to BEES for USDA.

BEES measures the environmental performance of building products by using the life-cycle assessment approach specified in the ISO 14040 series of standards. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Economic performance is measured using the ASTM standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental and economic performance are combined into an overall performance measure using the ASTM standard for Multi-Attribute Decision Analysis. For the entire BEES analysis, building products are defined and classified according to the ASTM standard classification for building

BEES: econ. & env. impacts

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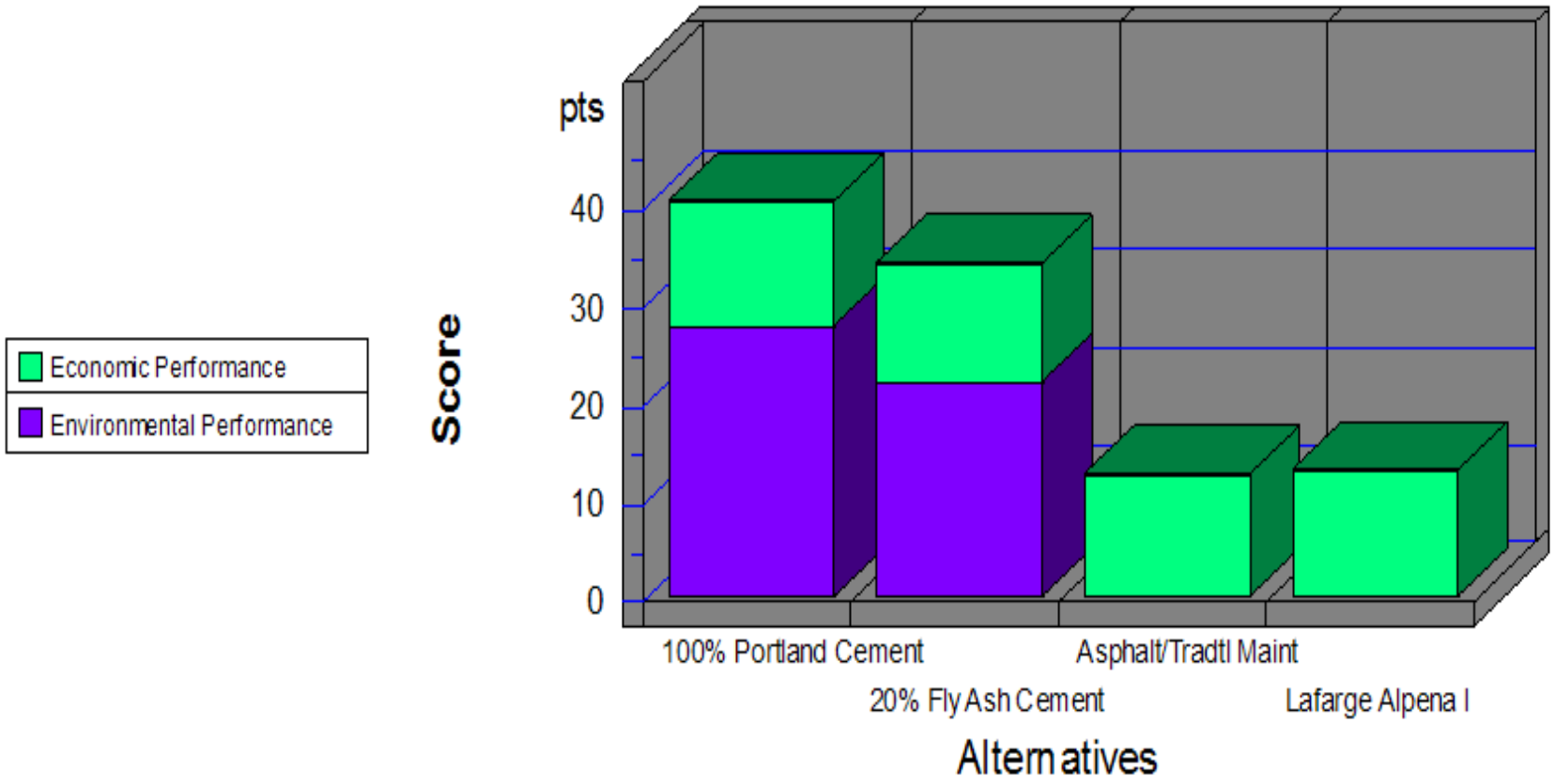
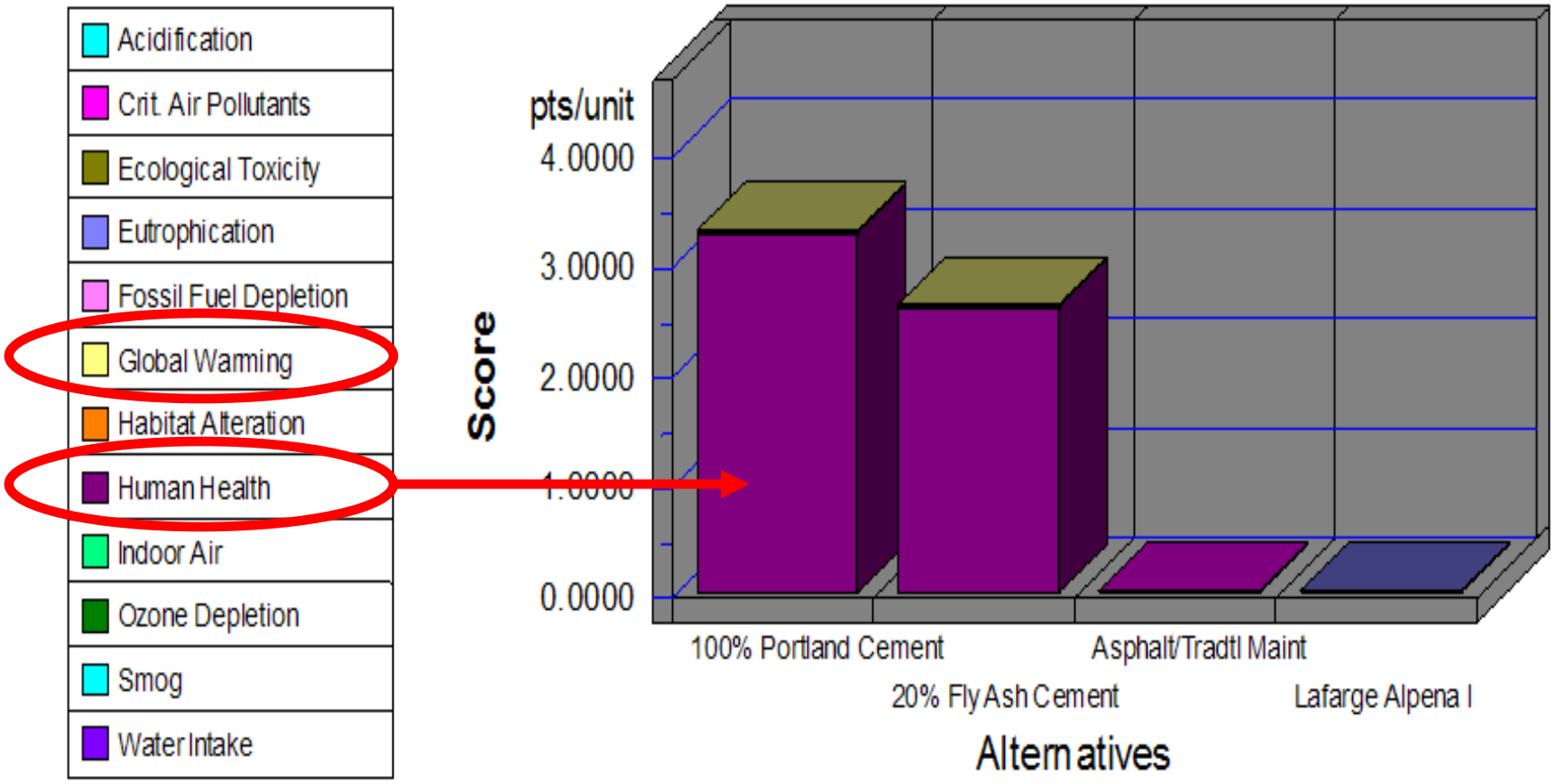
Overall Performance



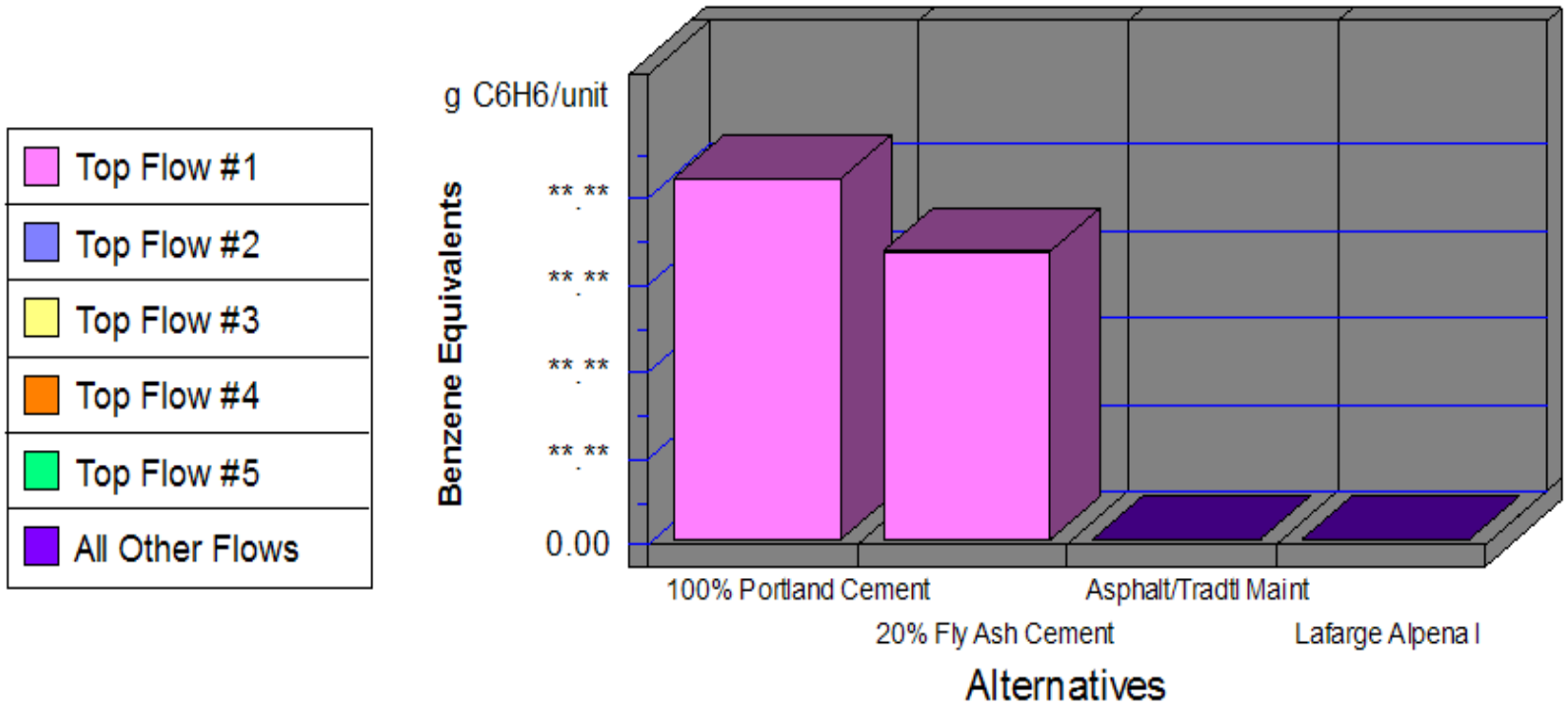
Note: Lower values are better

Environmental Performance



Note: Lower values are better

Human Health Cancer by Sorted Flows*

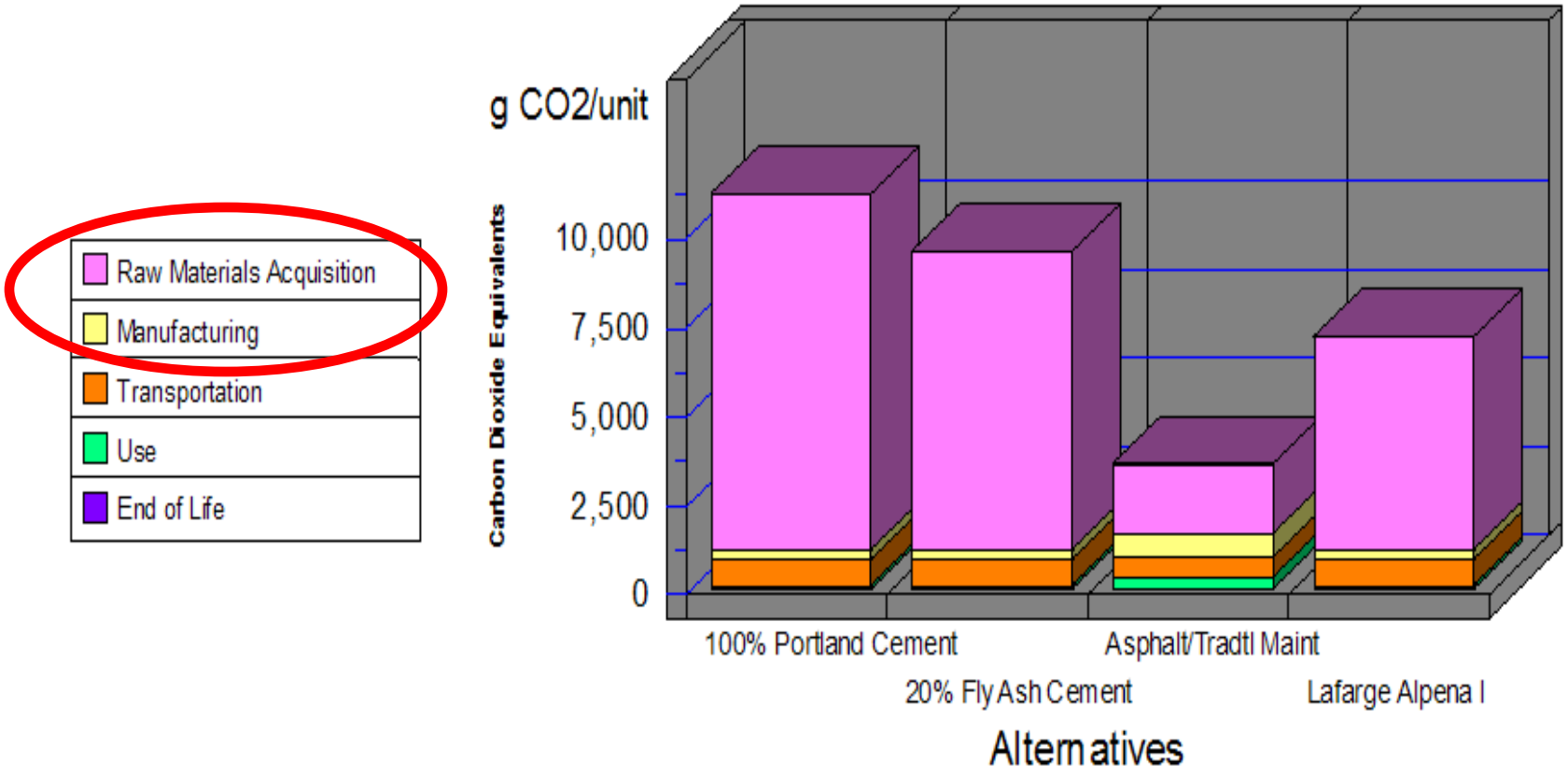


Note: Lower values are better

Category	100% OPC	20% FlyAsh	Asph/Trad	Lafarge I
Cancer--(a) Dioxins (unspecifie	2,087.00	1,660.52	0.41	0.49


Extra Cream ICE CREAM
CAUTION
proof of global warming
NAPA

Global Warming by Life-Cycle Stage



Note: Lower values are better

- Production of HMA pavement requires ~ 20% less ENERGY than vs construction of PCC pavement
  - but difficult to quantify
- UHI may be “real” but is only local; NOT a contributor to Global Warming – *Scientific American*
- Avg. automobile emits ~ 6 tons CO2 annually
- Avg. HMA plant emits ~ 2,500 tons CO2 = ~ 0.0023 Tg
- Cement industry emits ~ 45 Tg CO2
- HMA pavement unit @ ~ 30% vs. PCConcrete (BEES)
- Very few existing published info. but general support
- So, where is HMA industry vs. all GHG emissions . . .

carbon footprint: US sources

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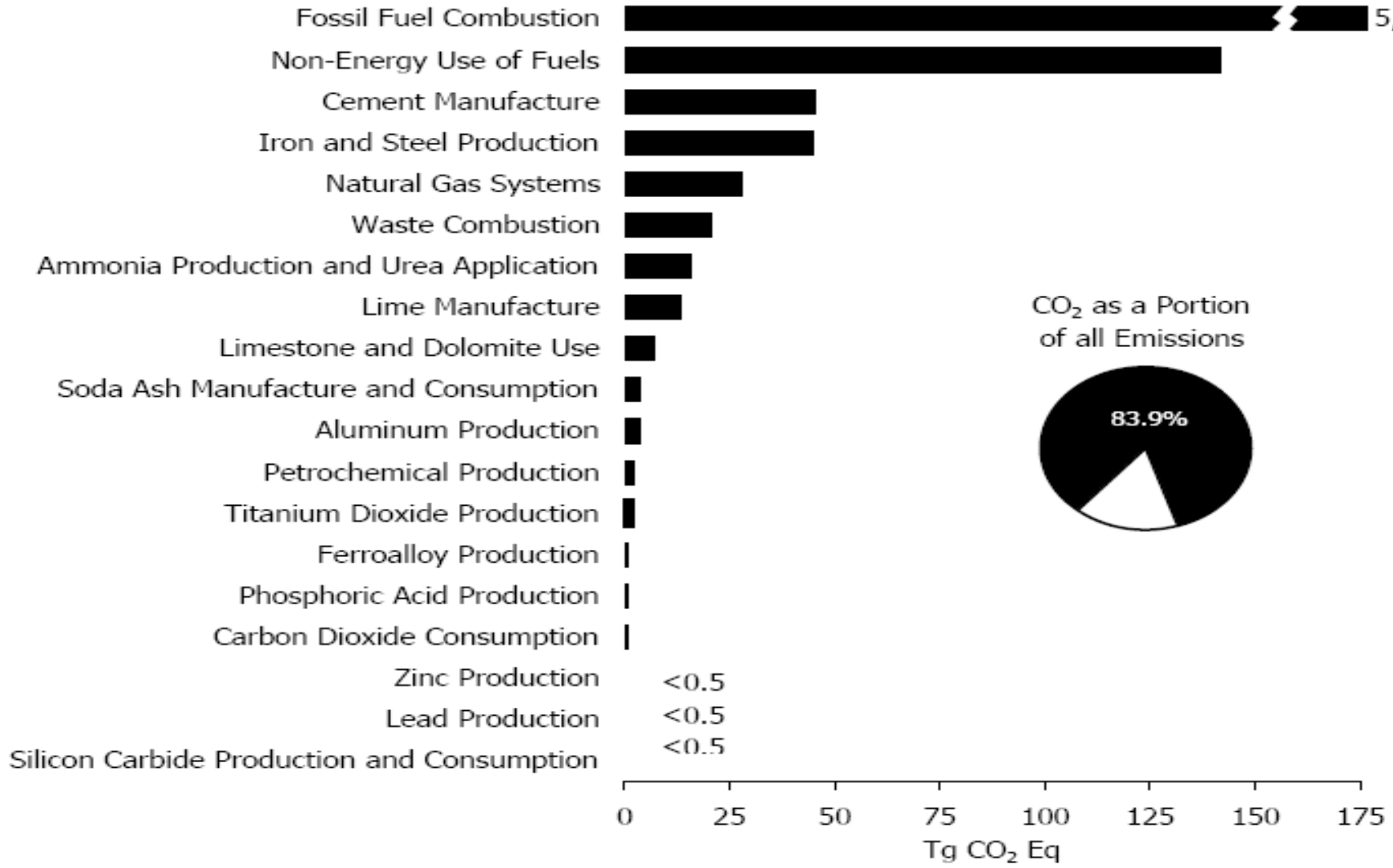

Figure ES-5: 2005 Sources of CO_2

carbon footprint: US sources

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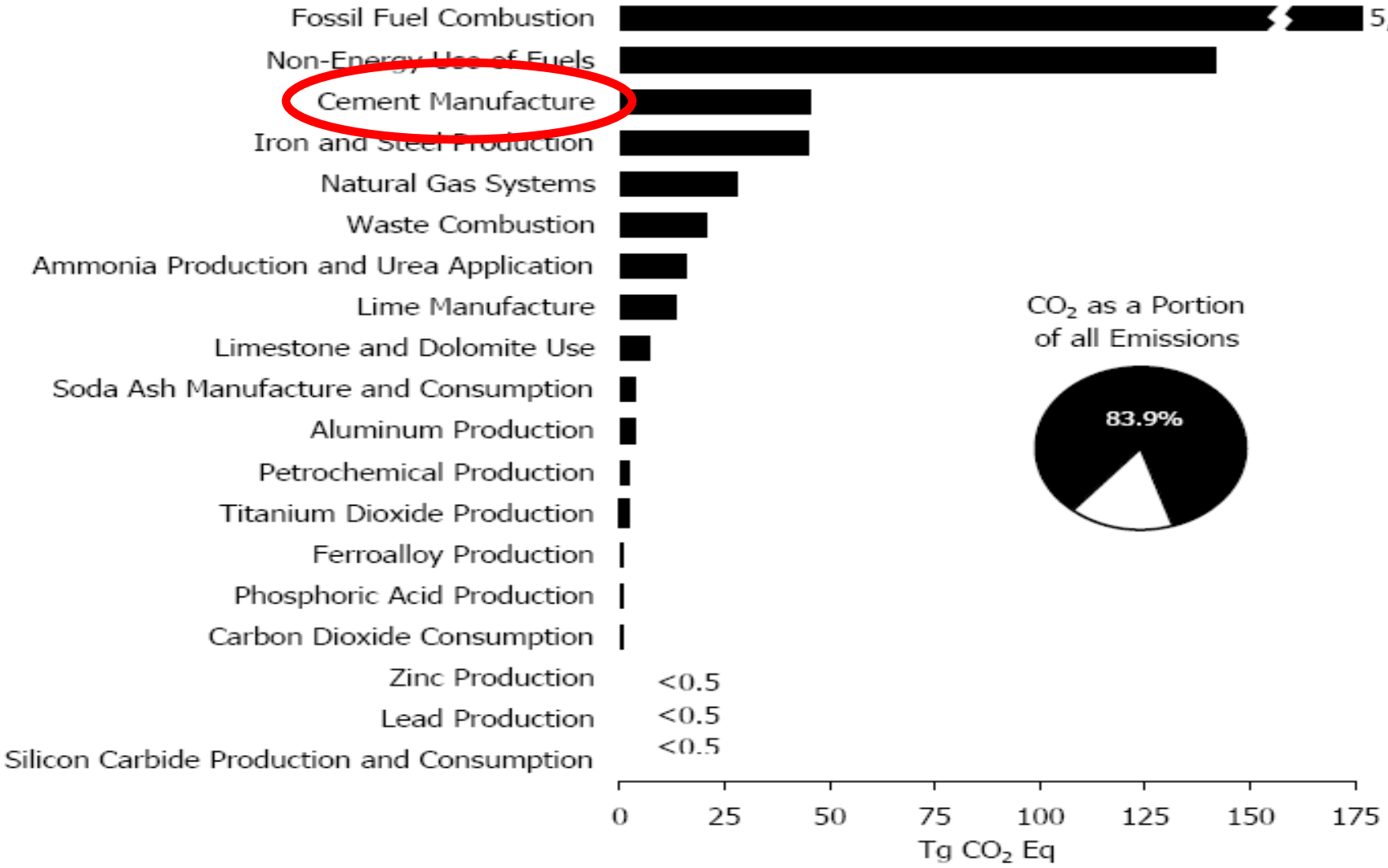


Figure ES-5: 2005 Sources of CO_2

carbon footprint: US sources

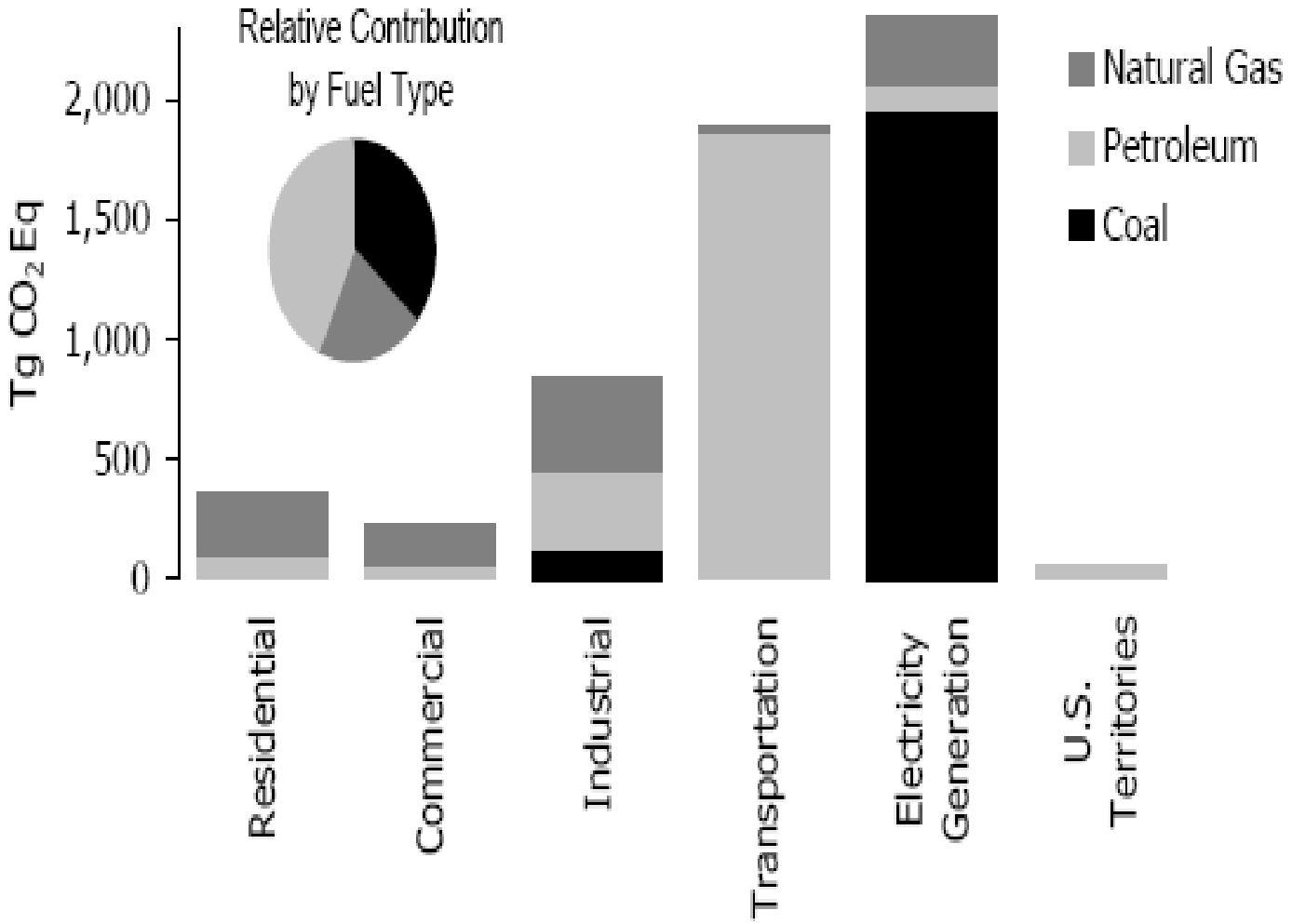
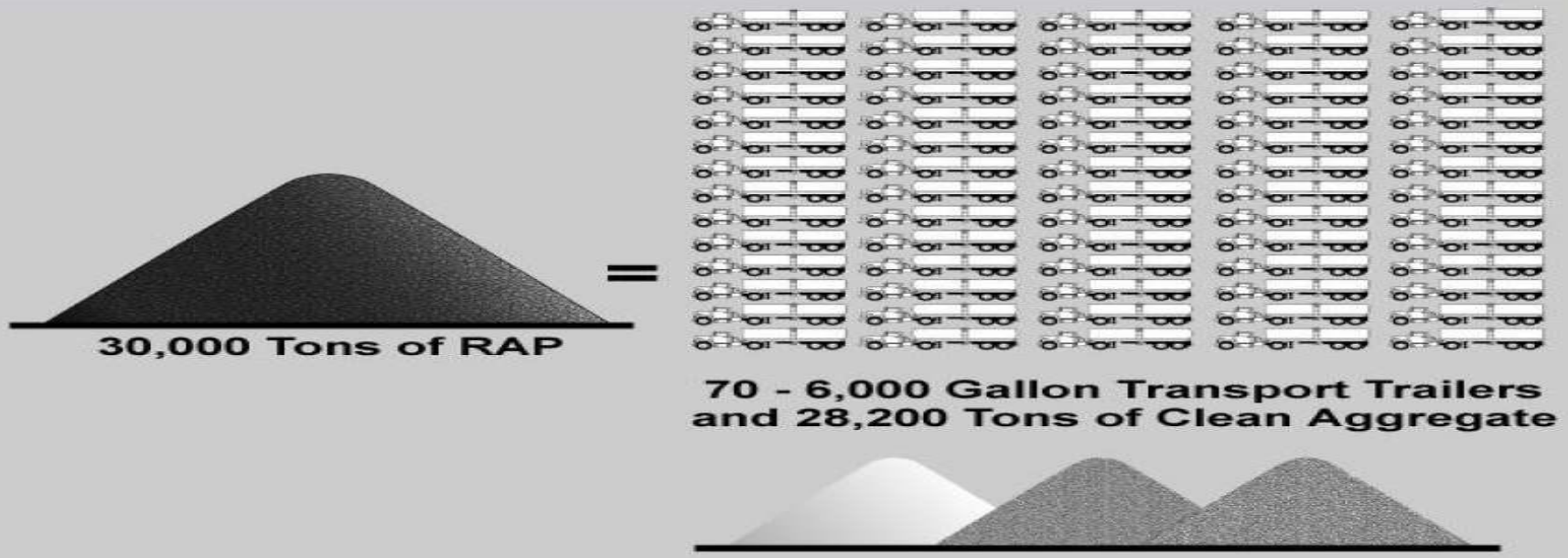


Figure ES-6: 2005 CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type

The entire annual CO2 / greenhouse gas emissions / carbon footprint from a typical hot-mix plant (~ 2,500 tons) could be totally offset by using greater than ~ 25% RAP in pavement mix designs -- accomplished by minimizing acquisition of energy intensive (natural) raw materials such as aggregate and petroleum asphalt.



RAP: sustainable & carbon neutral

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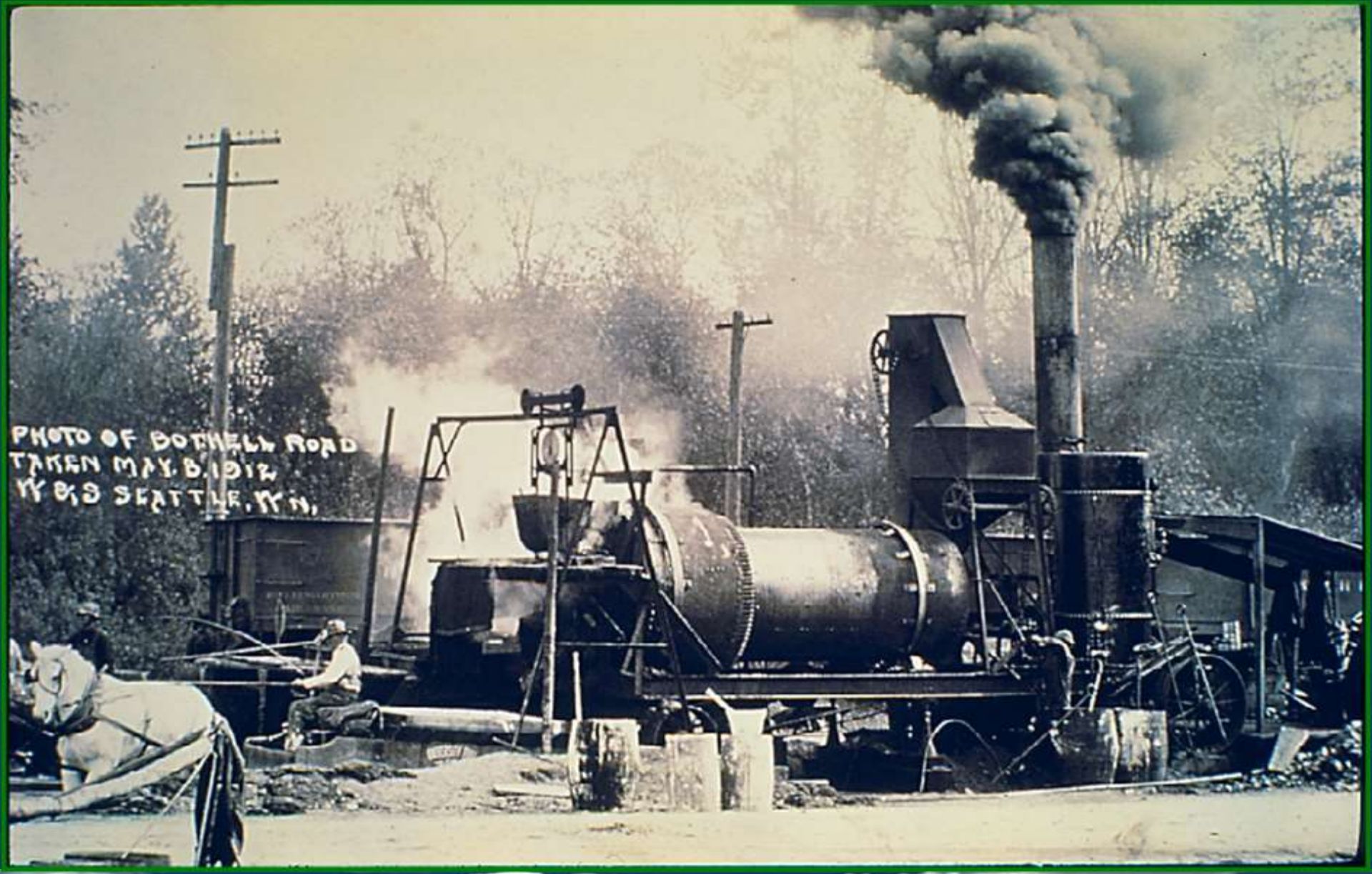

to drive efficiency = $$ / env comp

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Warm Mix Asphalt ("WMA")

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- Many different technologies
  - Additives such as waxes and zeolites
  - Emulsions and water foaming processes
  - Costs differ; some higher, some lower
- End-result: to lower mix temperatures from 300 oF → ~ 250 oF (or lower)
  - Less energy demand / fuel consumption
  - Less emissions: plant and field
- Quantifying energy and emissions
  - ~ 15% less fuel consumption
  - ~ 20% less CO_2 emissions
  - Lower NOx, particulate, other emissions
- States, Producers, Contractors, FHWA all interested
  - TRB funding @ ~ $2MM; performance/ emissions

ASPHALT:
the environmentally sustainable pavement

- Porous pavements manage stormwater
- OGFCs are safe and quiet
- Reflective / OGFC / Porous can mitigate UHI
  - Remember: UHI doesn't cause Global Warming
- Great pavement to help with LEED certification
  - Additional credits are possible
- Asphalt pvmts accept recycled goods / are recycled (RAP)
- HMA pavements are environmentally preferred
  - Less energy to construct, low carbon footprint, speed of construction, no emissions like dioxins
- Warm Mix lowers energy consumption & emissions
- RAP can offset the entire annual HMA GHG emissions

“it ain’t easy being green!”

NAPA


Questions ??
Getting “credit” for energy / GHG reductions: LEED / cap-and-trade
“it ain’t easy being green!”
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ASPHALT

The Sustainable Pavement

ENERGY & RECYCLING

PERFORMANCE

WATER QUALITY

CLEAN AIR & COOL CITIES

Asphalt is the sustainable material for constructing pavements.

From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction.

www.pavegreen.com

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