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

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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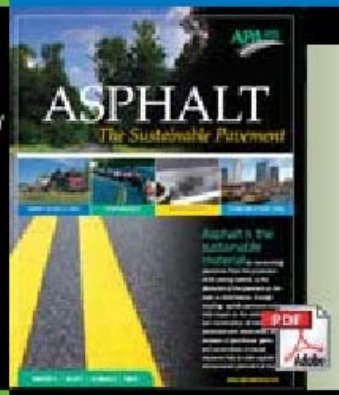
ASPHALT *The Sustainable Pavement*

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

DOWNLOAD



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

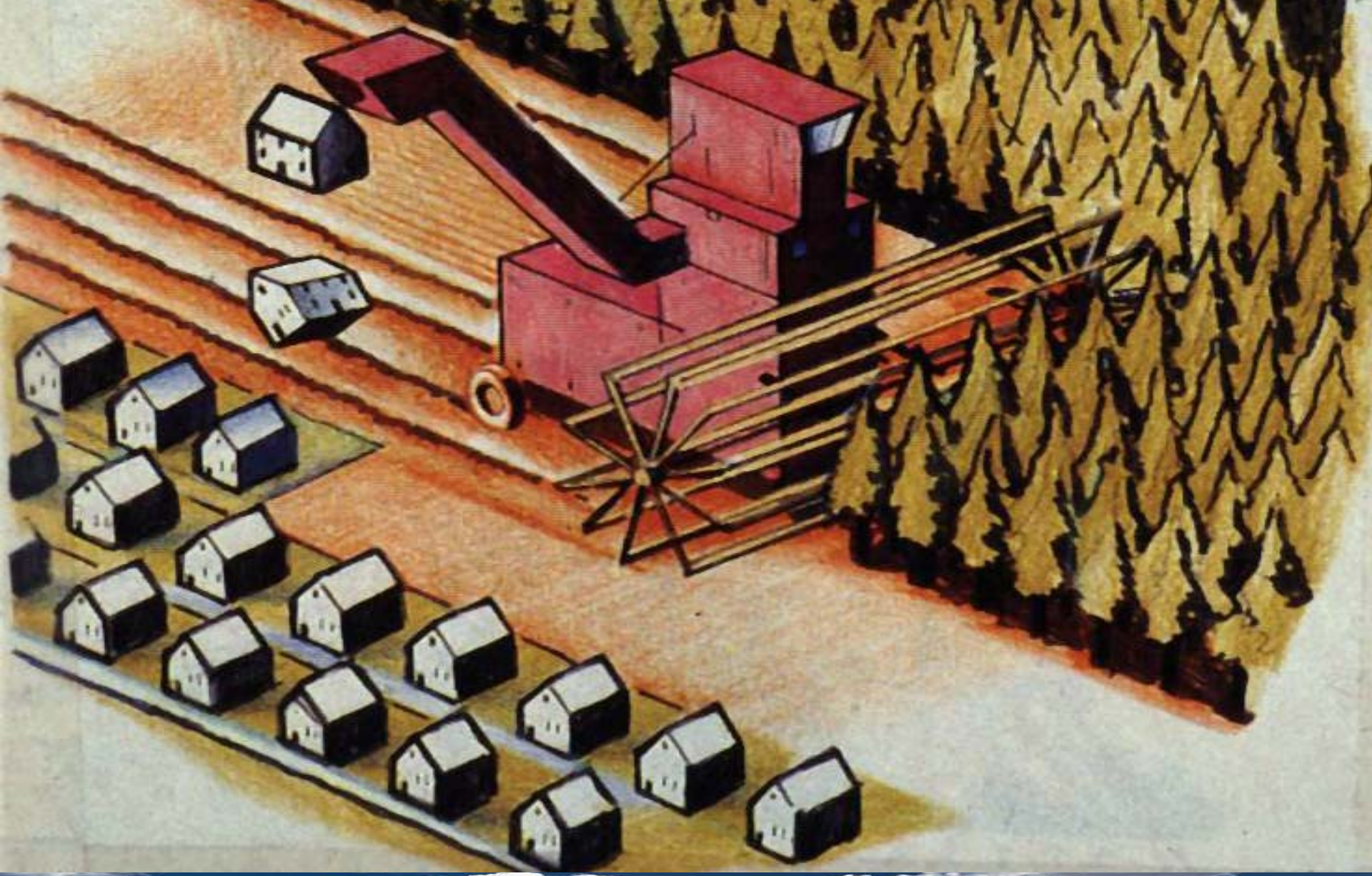
According to an EPA/FHWA study,[2] the asphalt industry recycles more than 70 million tons of its own product every year, making it America's number one recycler. Asphalt recycling saves taxpayers about $1.8 billion a year.

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

NAPA


urban development
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stormwater management
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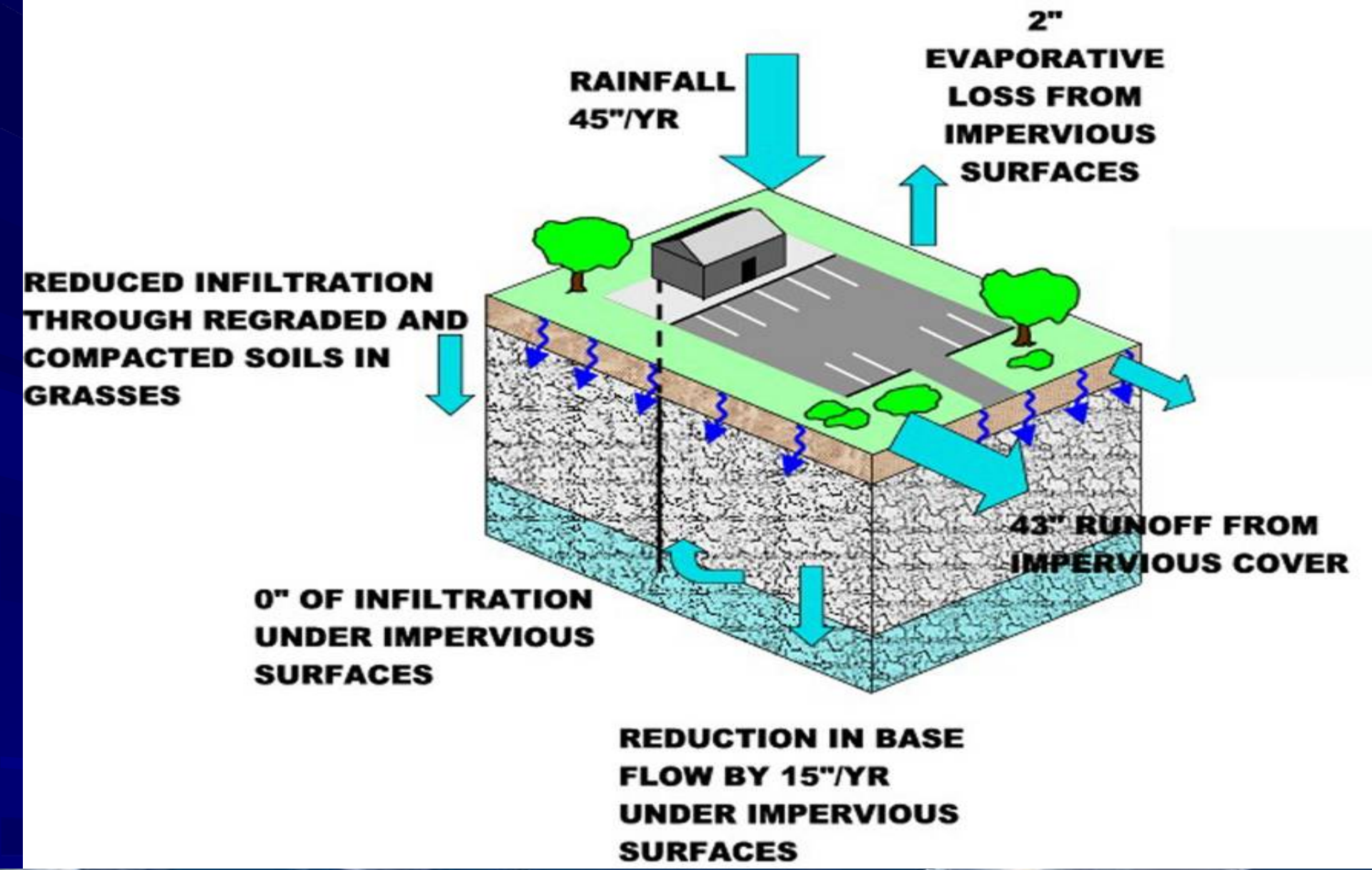
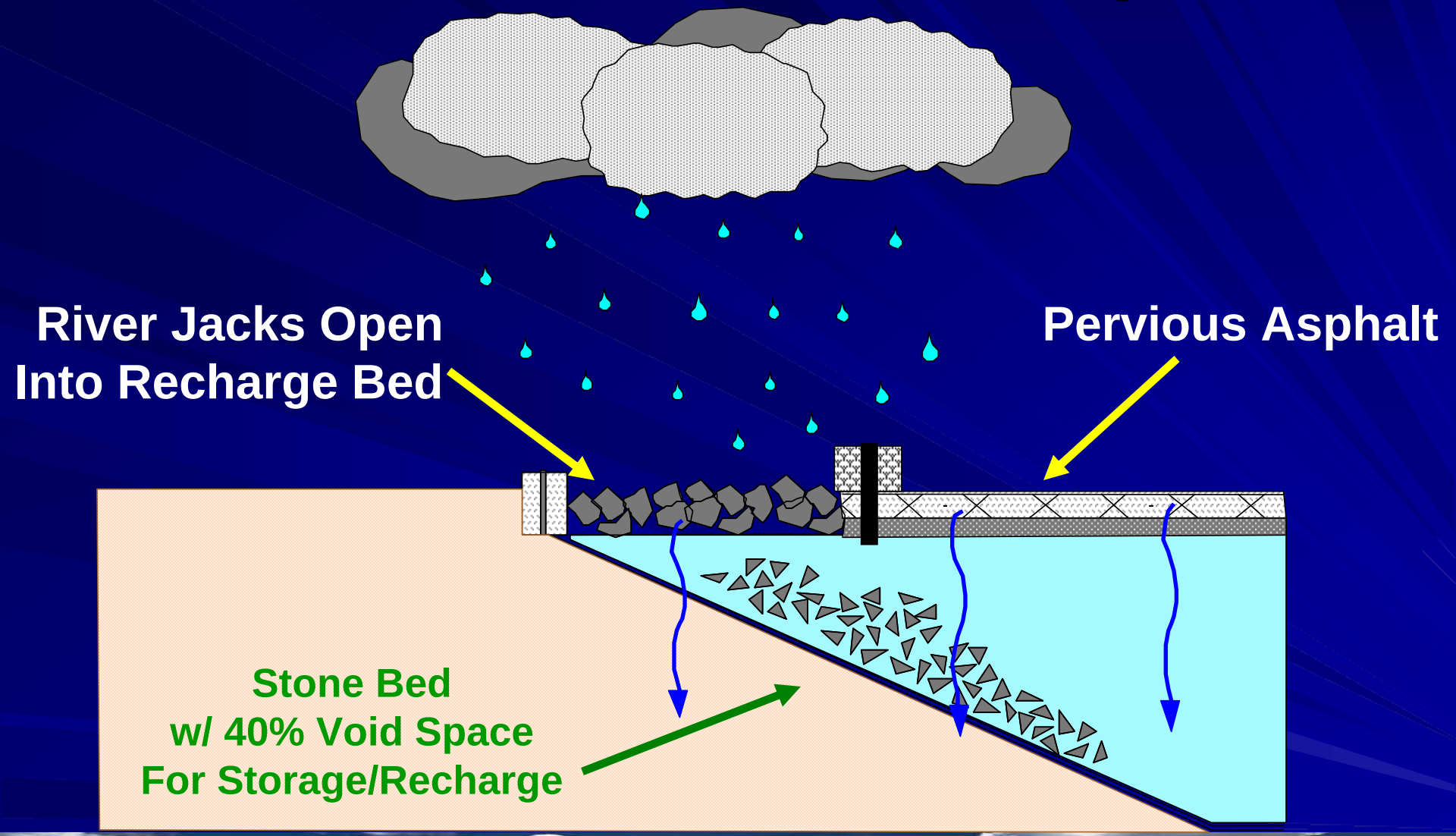

RAINFALL
45"/YR
2"
EVAPORATIVE
LOSS FROM
IMPERVIOUS
SURFACES
REDUCED INFILTRATION
THROUGH REGRADED AND
COMPACTED SOILS IN
GRASSES
43" RUNOFF FROM
IMPERVIOUS COVER
0" OF INFILTRATION
UNDER IMPERVIOUS
SURFACES
REDUCTION IN BASE
FLOW BY 15"/YR
UNDER IMPERVIOUS
SURFACES

Porous Pavement with Recharge Bed




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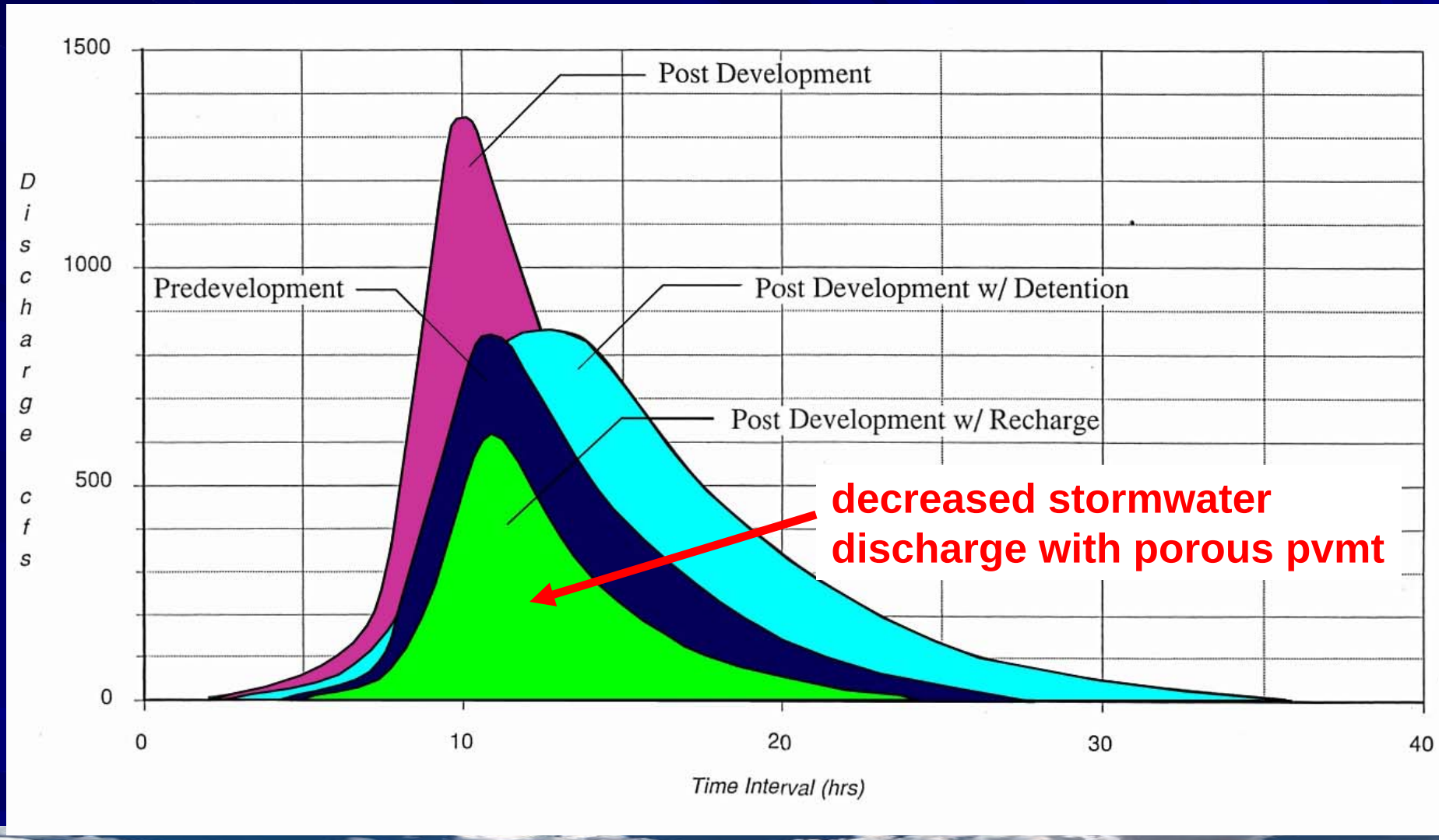
Univ. NC: add'l parking lot constructed ca. 2002

Comparison of Detention vs. Infiltration System



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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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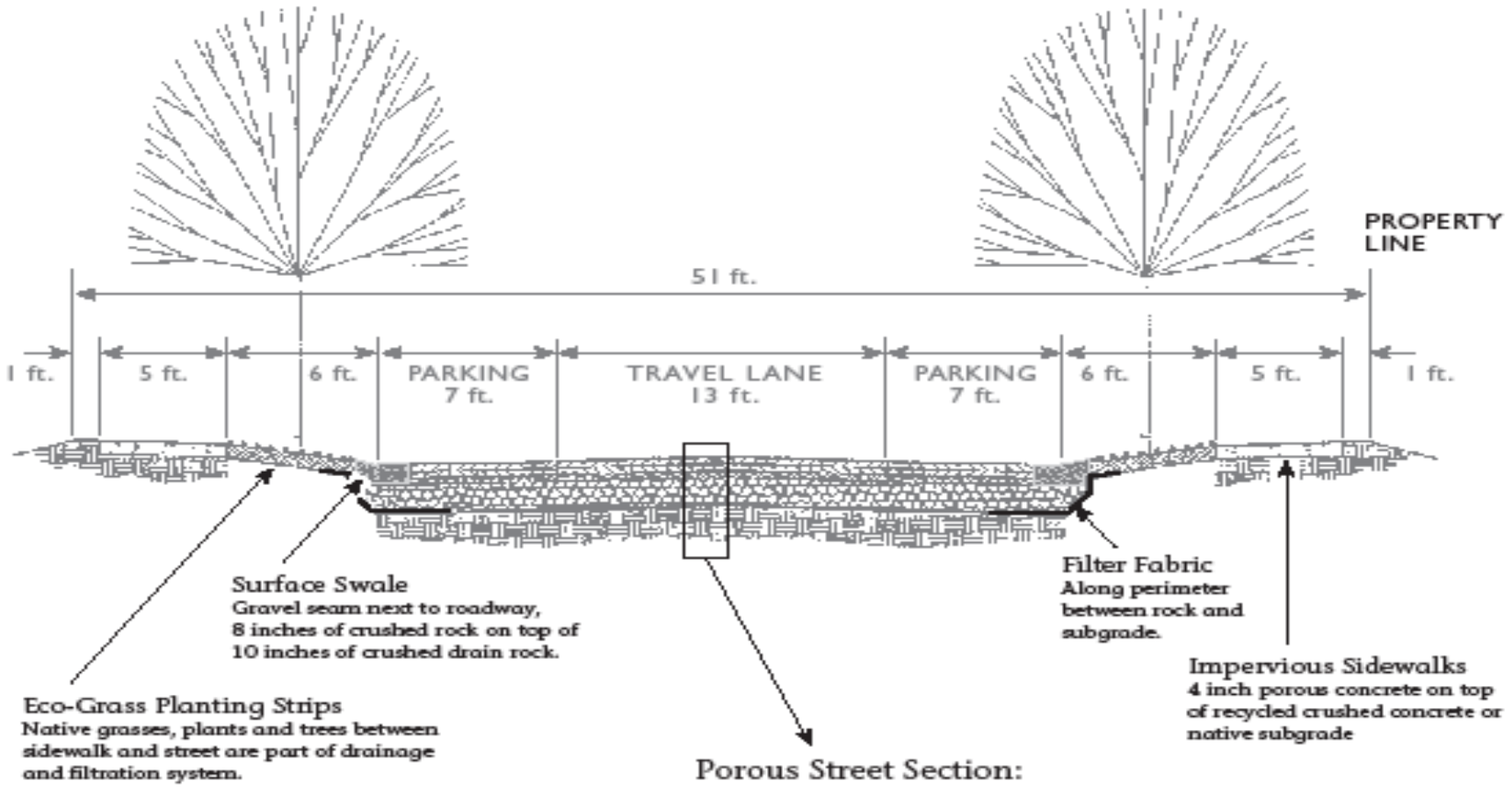
WHAT IS A GREEN STREET?



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)

quieter pavements

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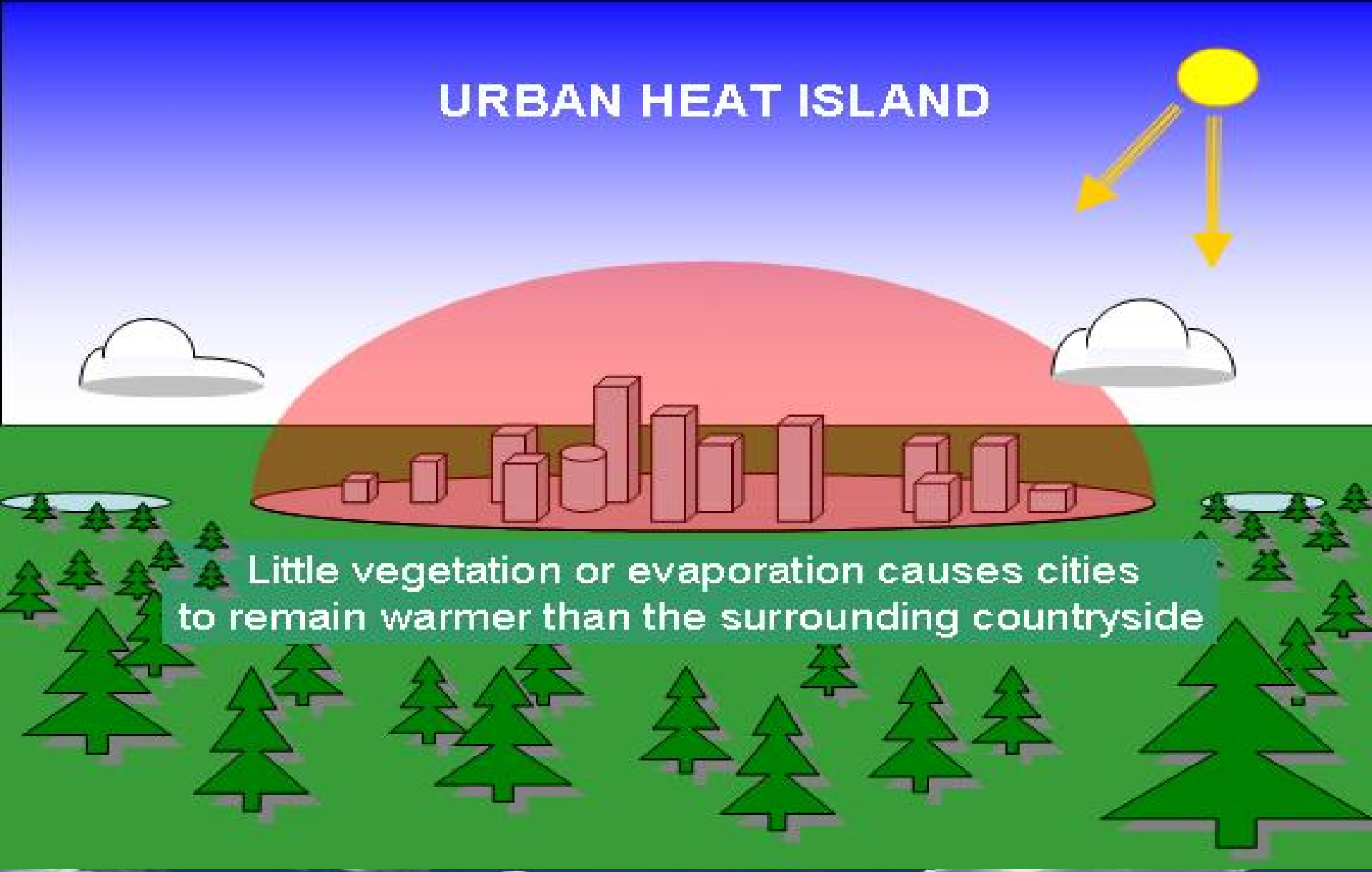
Noise Reduction: AR-OGFC on Highway



Urban Heat Islands

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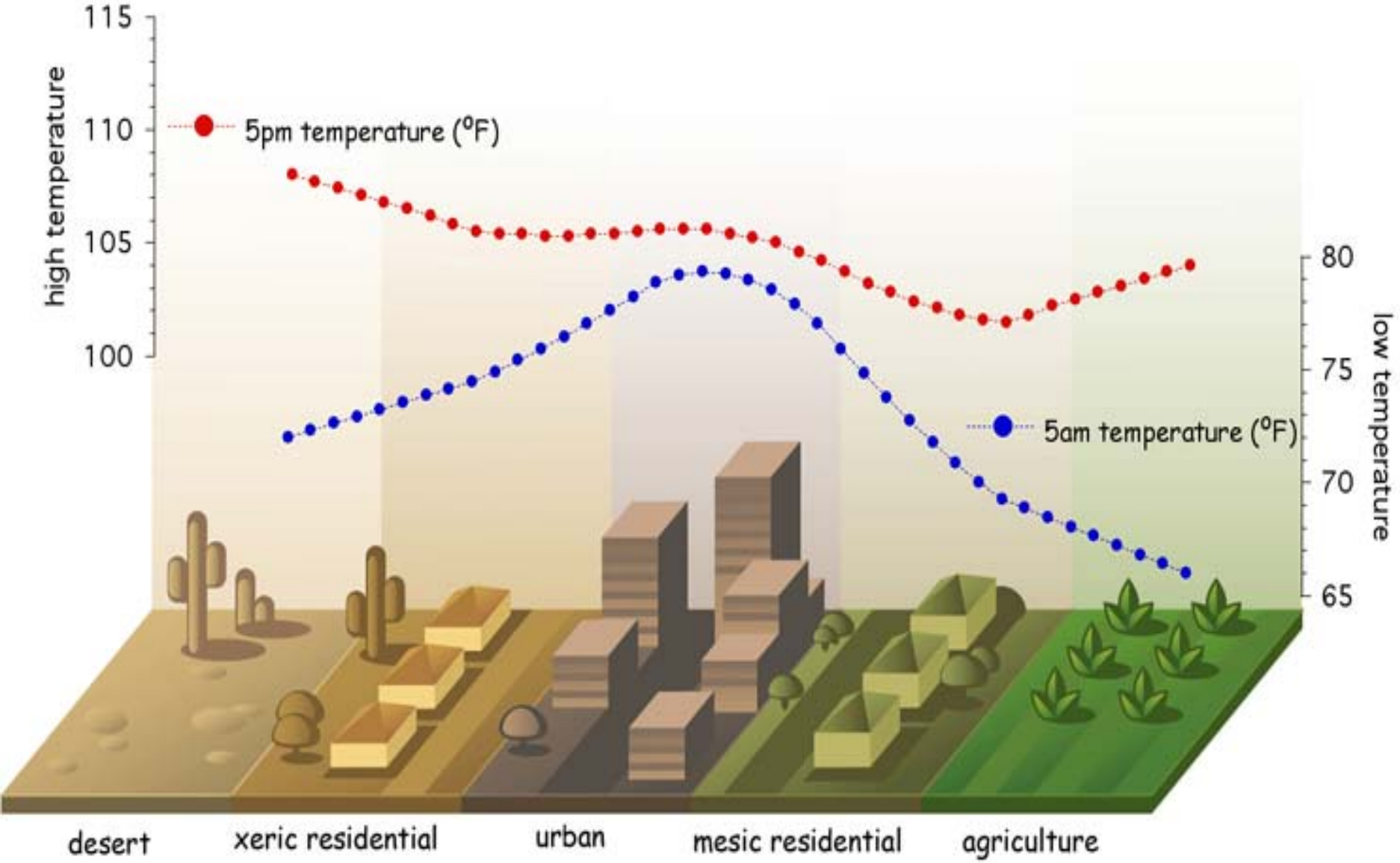

Urban Heat Islands

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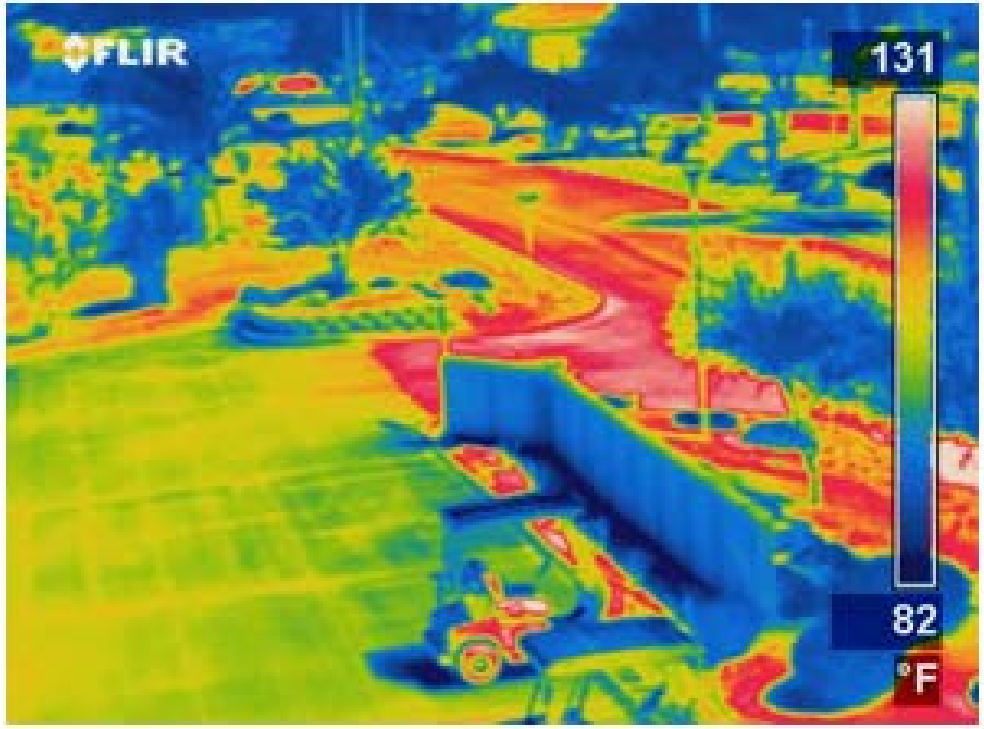

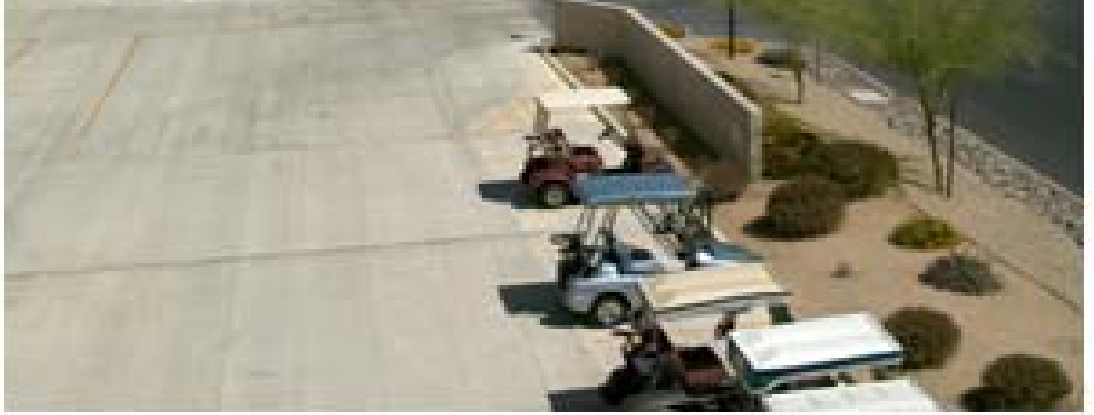

pavement type & temperatures

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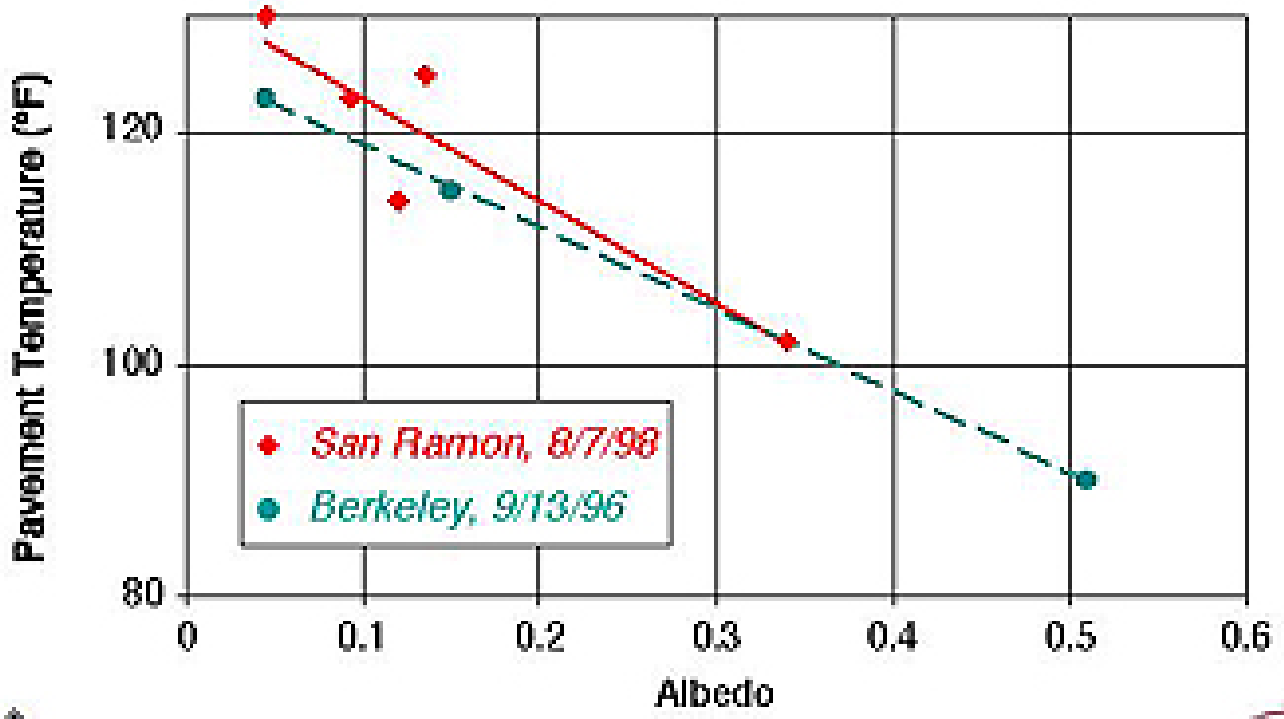
Pavement Temperatures *vs.* Albedos



myth or reality ?

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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SMART INNOVATIONS FOR URBAN CLIMATE AND ENERGY
ARIZONA STATE UNIVERSITY

reflectivity & temperatures

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

huh ??

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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)

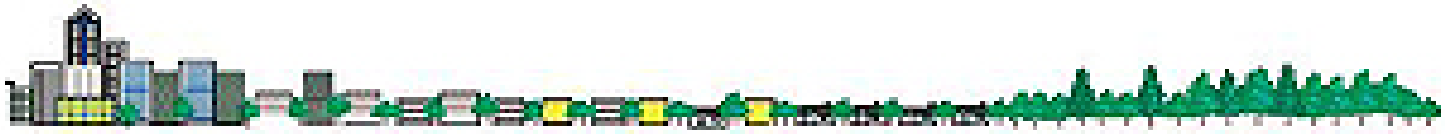
- ***Input:***

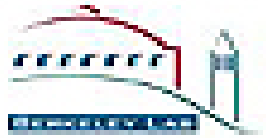
Albedo change =	**0.25**
Pavement area =	1,250 km^2
Urban area =	10,000 km^2

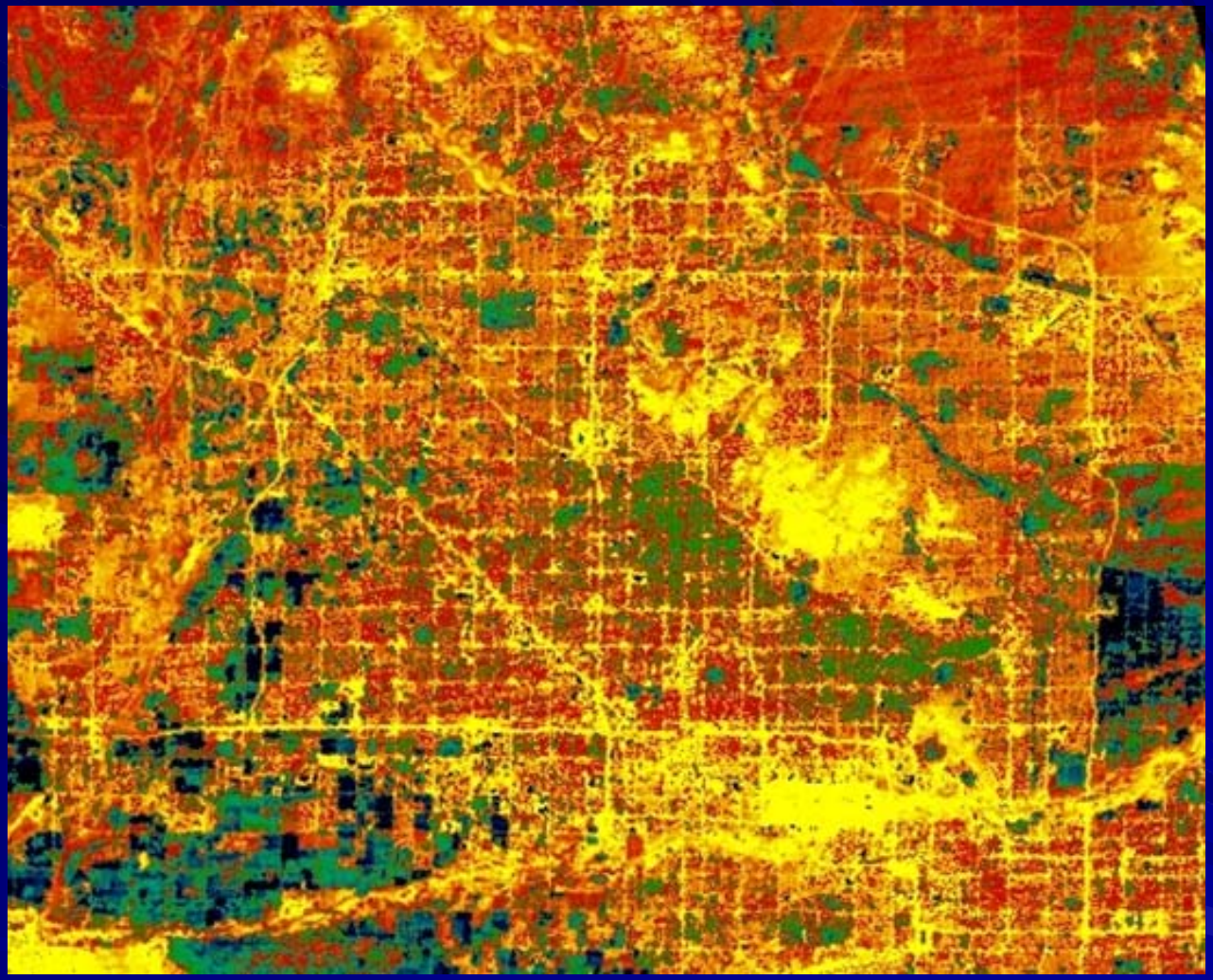
Normal LA weather

- ***Result:***

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







cooler pavements

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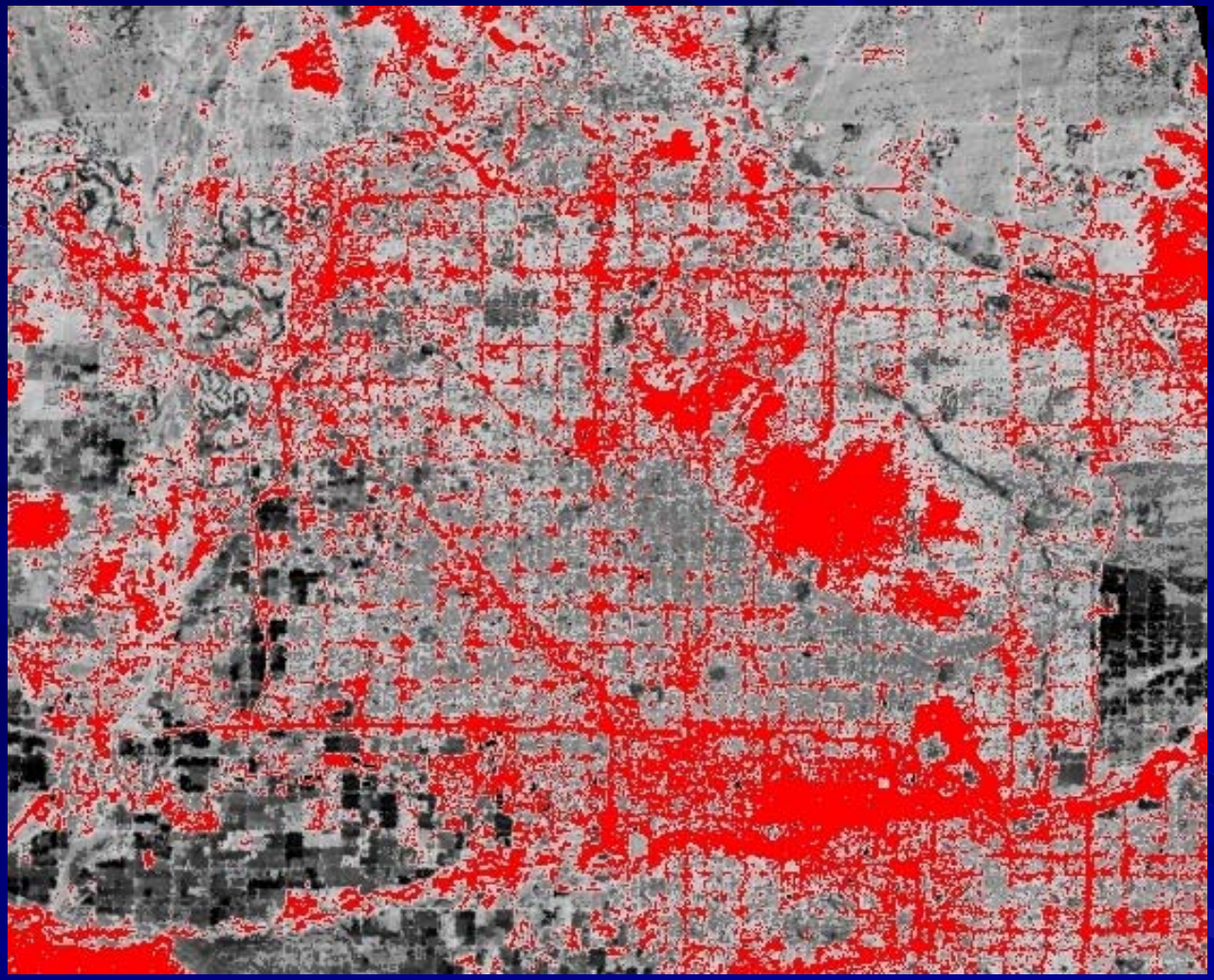

cooler pavements

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cooler pavements

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Heat Island Effect

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- Where You Live
- Energy Savings
- Heat, Health & Environment
- Research
- What Can Be Done
  - Community Actions
  - Cool Roofs
  - Green Roofs
  - Trees & Vegetation
  - Cool Pavements
- Pilot Project (UHIPP)
- Newsroom
- Publications
- Calendar
- Related Links
- Frequent Questions
- Glossary

Cool Pavements

■ - Denotes link to glossary definition

There is no official standard or labeling program to
early stage.

While studies show that pavements can affect the
several factors. These include the impact of shado
time; and the absorption by buildings of solar radia

There are situations, however, where communities
that lower surface temperature and achieve relate
roadways with large expanses of paved surface a

Investigations of cool paving materials have focuse
Pavements with higher solar reflectance■ are coo
pavements benefit from the cooling effect of evapo
construction are essential in applying either cool pa

Other factors affecting performance, cost, and be
the best solutions may occur where multiple benef
help with storm water runoff as well as provide a c

CLEARING UP the Confusion about Smoothness and Texture

Fourth Quarter 2005, Vol. 1, No. 1

SURFACE TRANSPORTATION

The magazine of the American Concrete Pavement Association
www.pavement.com

ACPA

? cooler reflective pavements ?

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Investiga
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CLEARING UP the Confusion about Smoothness and Texture

SURFACE TRANSPORTATION

CONCRETE IS COOL FOR THE ENVIRONMENT

A lighter shade of GRAY
Environmental benefits of concrete

The magazine of the American Concrete Pavement Association
www.pavement.com

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It's NOT a black and white issue

? cooler reflective pavements ?

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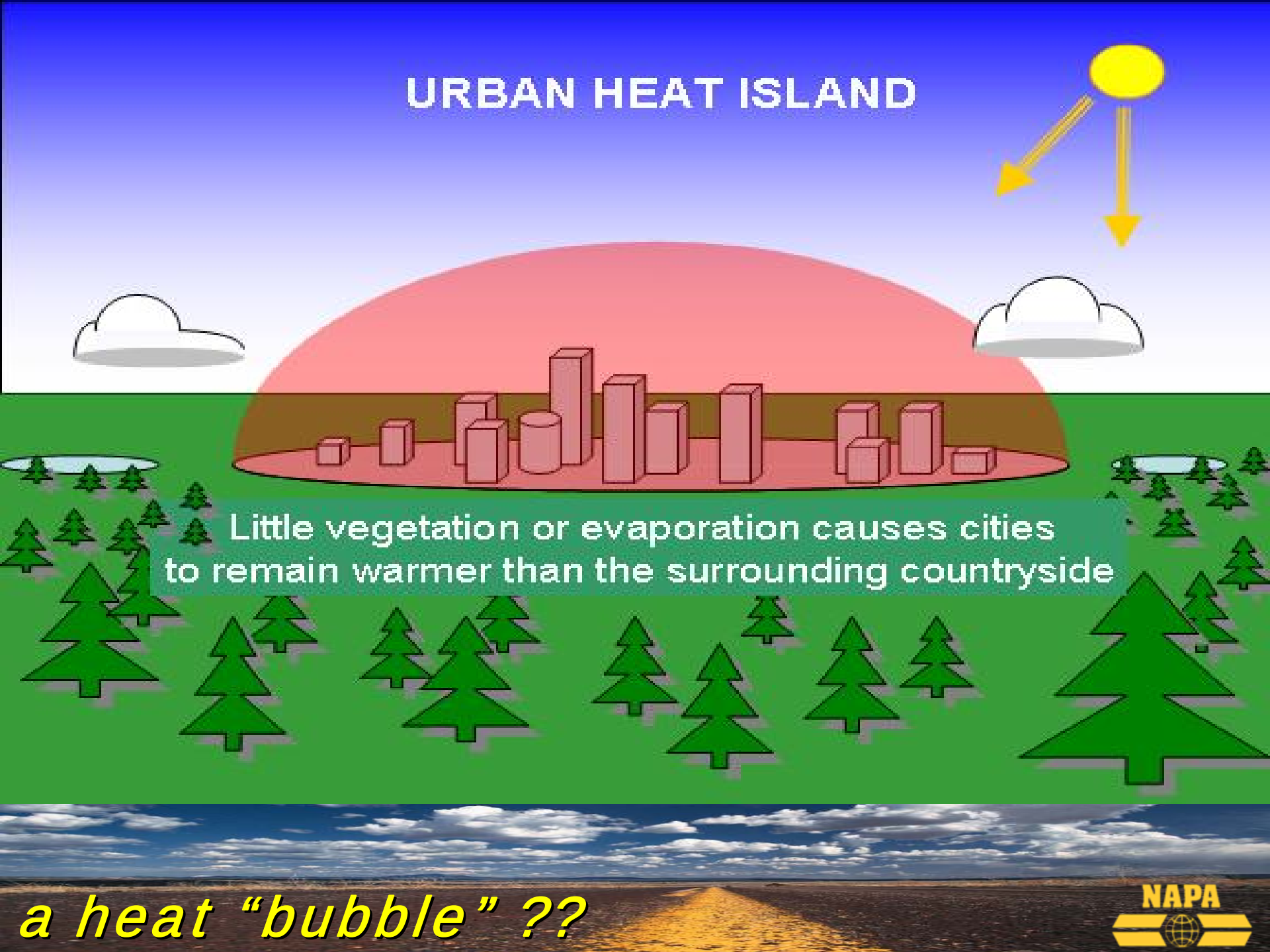
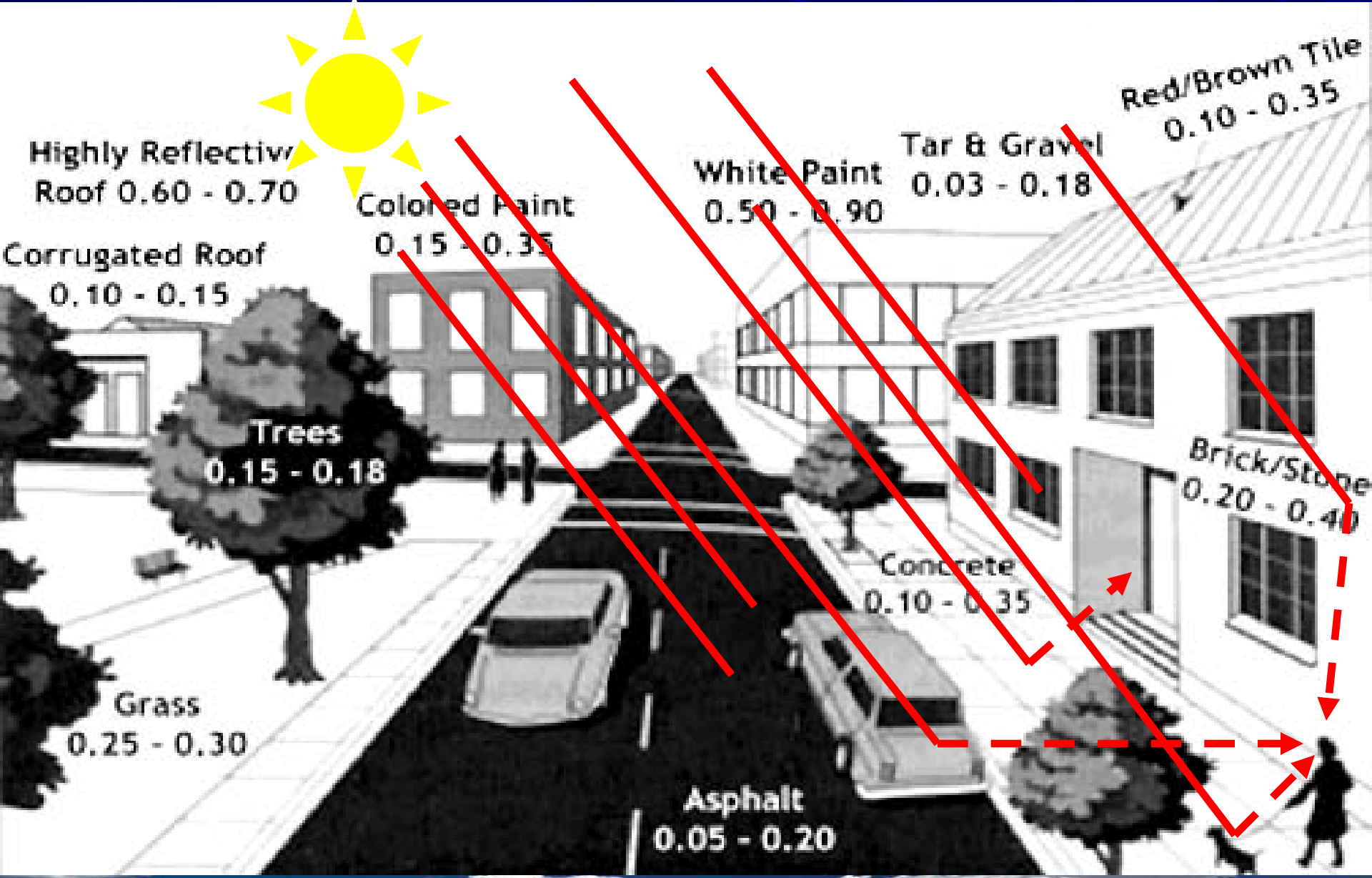

URBAN HEAT ISLAND
Little vegetation or evaporation causes cities
to remain warmer than the surrounding countryside
a heat “bubble” ??
NAPA



not quite . . .

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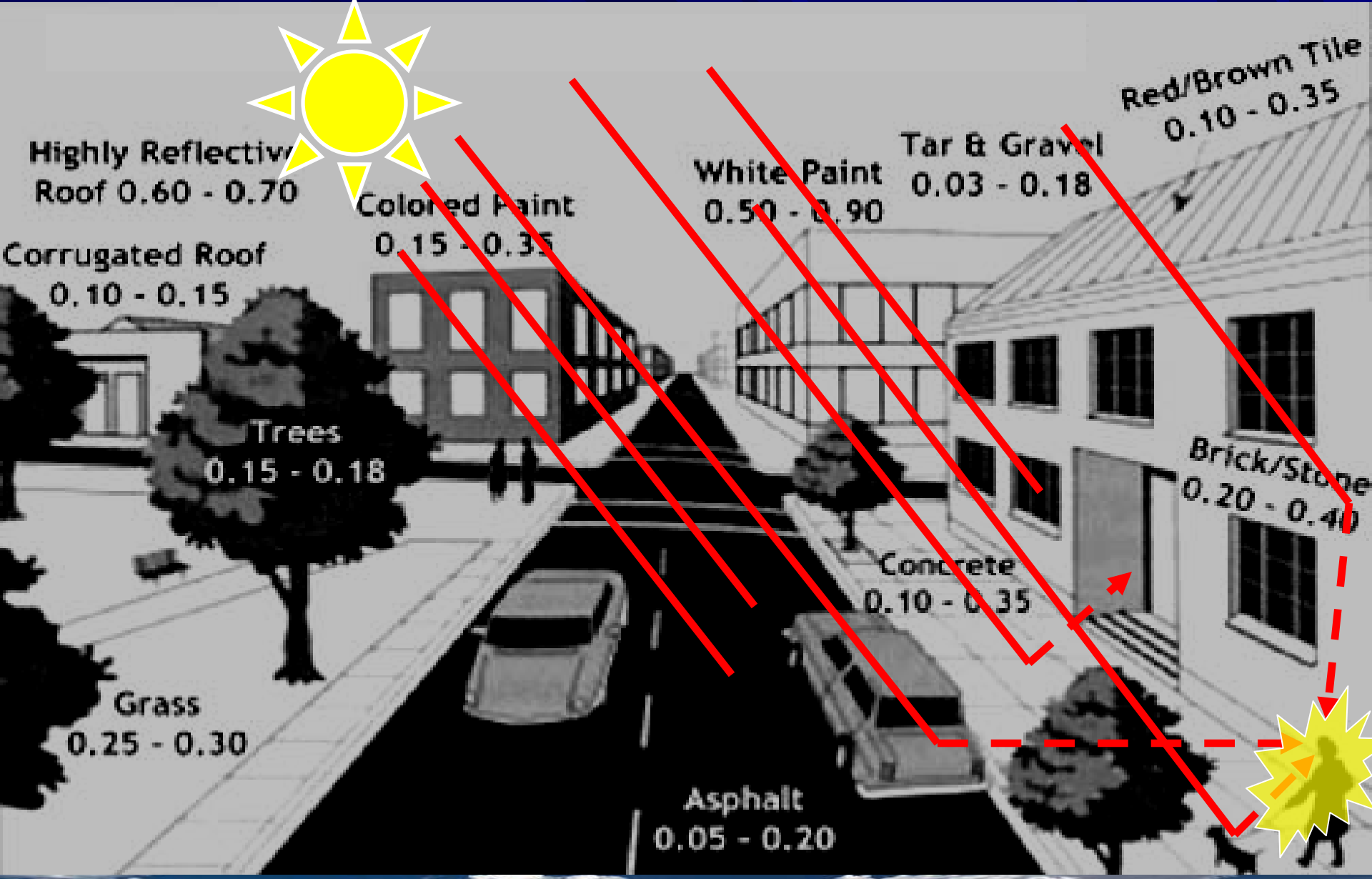

not quite . . .

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- What happens after solar radiation strikes a pvmt surface
  - Dark pavements absorb / re-radiate as heat (night)
  - Light pavements reflect as UV radiation (day)
    - Heats up near-surface air / Heats up buildings
    - Provides catalyst for increasing ground-level ozone
    - Increases potential personal UV radiation exposure
- Pavement thickness and material capacities
  - Thicker pavements retain more heat (Phoenix)
  - (near) surface temperature vs air temperature
- Pvmt design has “net zero” balance on UHI temperatures
- Concrete pvmt is NOT necessarily cooler than asphalt
- Porous (OGFC) asphalt pavements are COOLer
- UHI does NOT cause Global Warming . . . Sci. Am.
- specialized binders are expensive but . . .

think about it . . .

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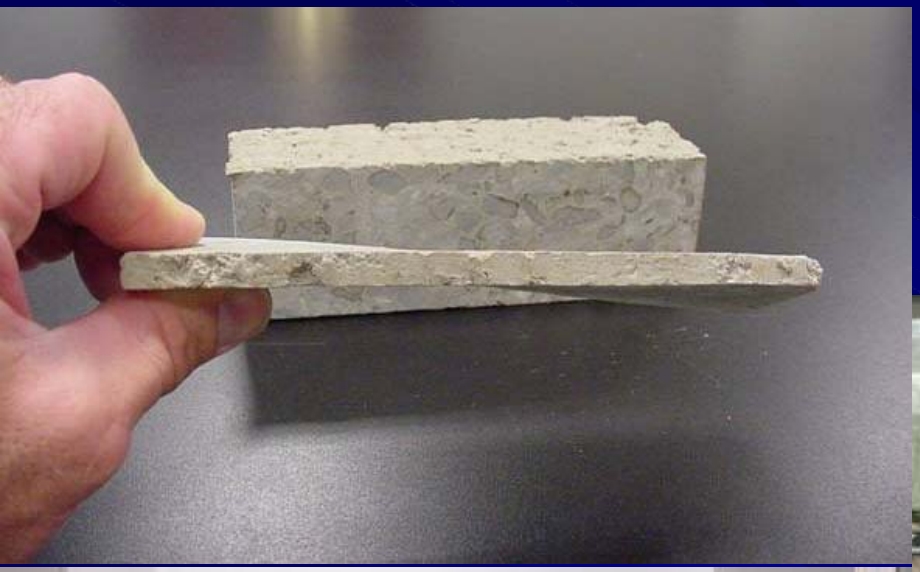
Surface Chip Seals and Coatings:
using reflective / light-colored chip / paints

“Gritting”:
reflective chips and aggregate

Shot-Blasting:
abrading surface binder

Synthetic and Colored Binders:
using reflective aggregates



Synthetic / Colored Binders:
using reflective / colored aggregates

- 20,000 sq. ft. parking lot
- Conventional HMA @ ~ $1.35 sq ft.
  - $400/ton binder, 3” thick, $75/ton HMA, ~ 400 tons HMA total
- PCConcrete pvmt @ ~ $5.75 sq ft.
  - standard depth of ~ 6-8”w/ wire mesh etc; range $4 - $8
- Colored HMA pvmt @ ~ $2.50 sq ft.
  - $2,000/ton binder, 3”, = ~ $140/ton HMA; material costs / placed
  - more labor involved re cleaning plant equip etc
- Densiphalt (cement grout over OGFC) @ ~ $4 sq ft
  - includes placement of 2” OGFC only + std labor;
  - range $3.50 - $5; process needs an existing (HMA) pvmt base
- Other technologies . . .
- specialized binders are expensive but . . .

sq. ft. cost basis

NAPA

- $2,000 / ton binder only doubles the sq. ft price
- Triple current HMA price is still competitive
- Densiphalt is current “alternative” to PCC for LEED credit – customers are purchasing
- Small volumes, specialized market, but GROWING
- Other technologies are much less $$
- HOW and WHY does this fit into LEED ???

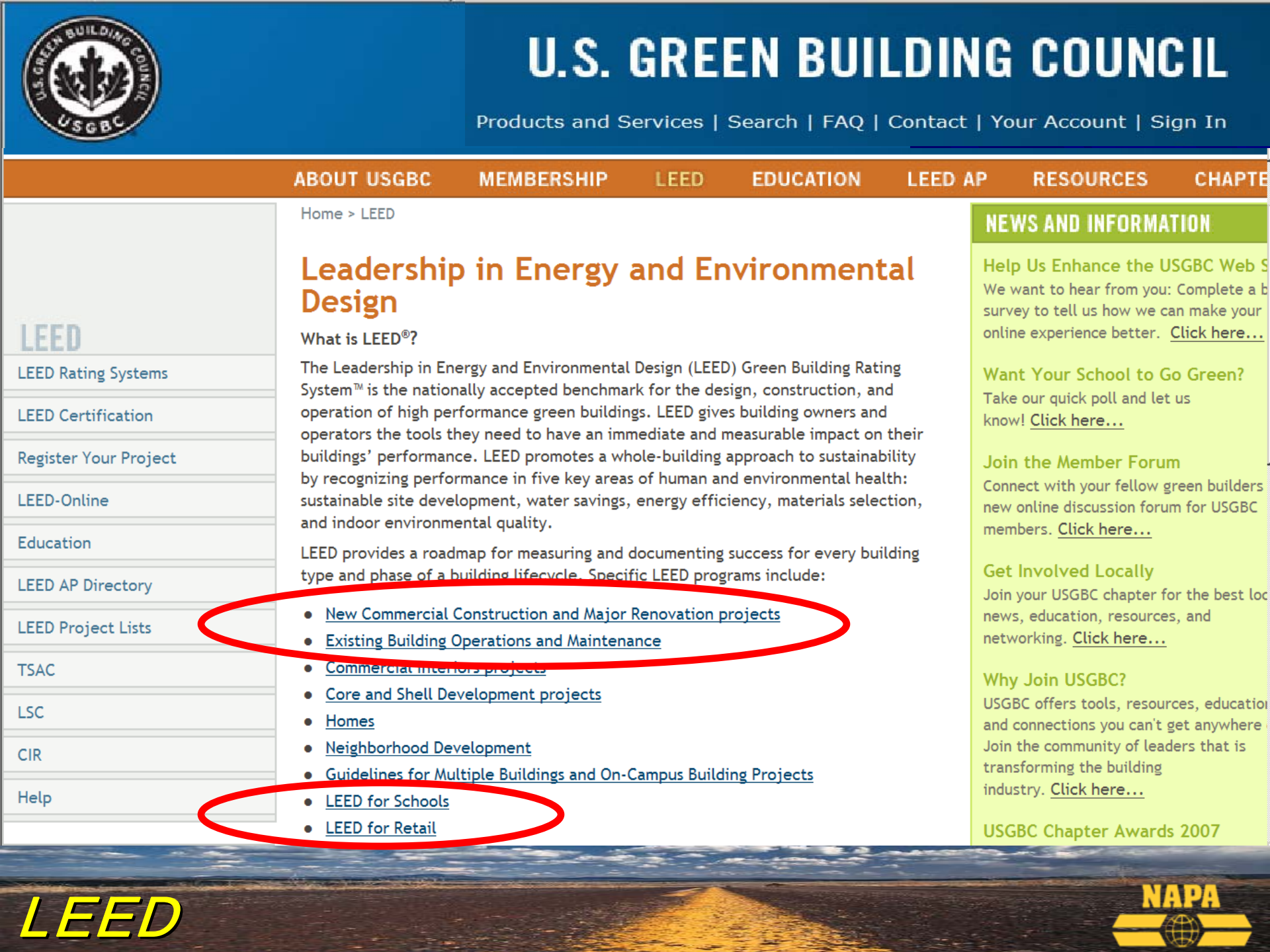
- specialized binders are expensive but . . .

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 . . .

- HOW and WHY does this fit into LEED ???

- specialized binders are expensive but . . .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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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USGBC Chapter Awards 2007
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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

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**	4
	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)	
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

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

from asphalt

5
+
8
—
13

Reuse up to 10%
Recycled up to 20%

LEED process

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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
  - Overall environmental impact might be less, e.g., UV radiation
  - Porous pvmts / OGFC might mitigate – petition
- By Show of Hands . . . Lost jobs to reflectivity?

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

huh ??

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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SMART INNOVATIONS FOR URBAN CLIMATE AND ENERGY
ARIZONA STATE UNIVERSITY

UHI: think about it . . .

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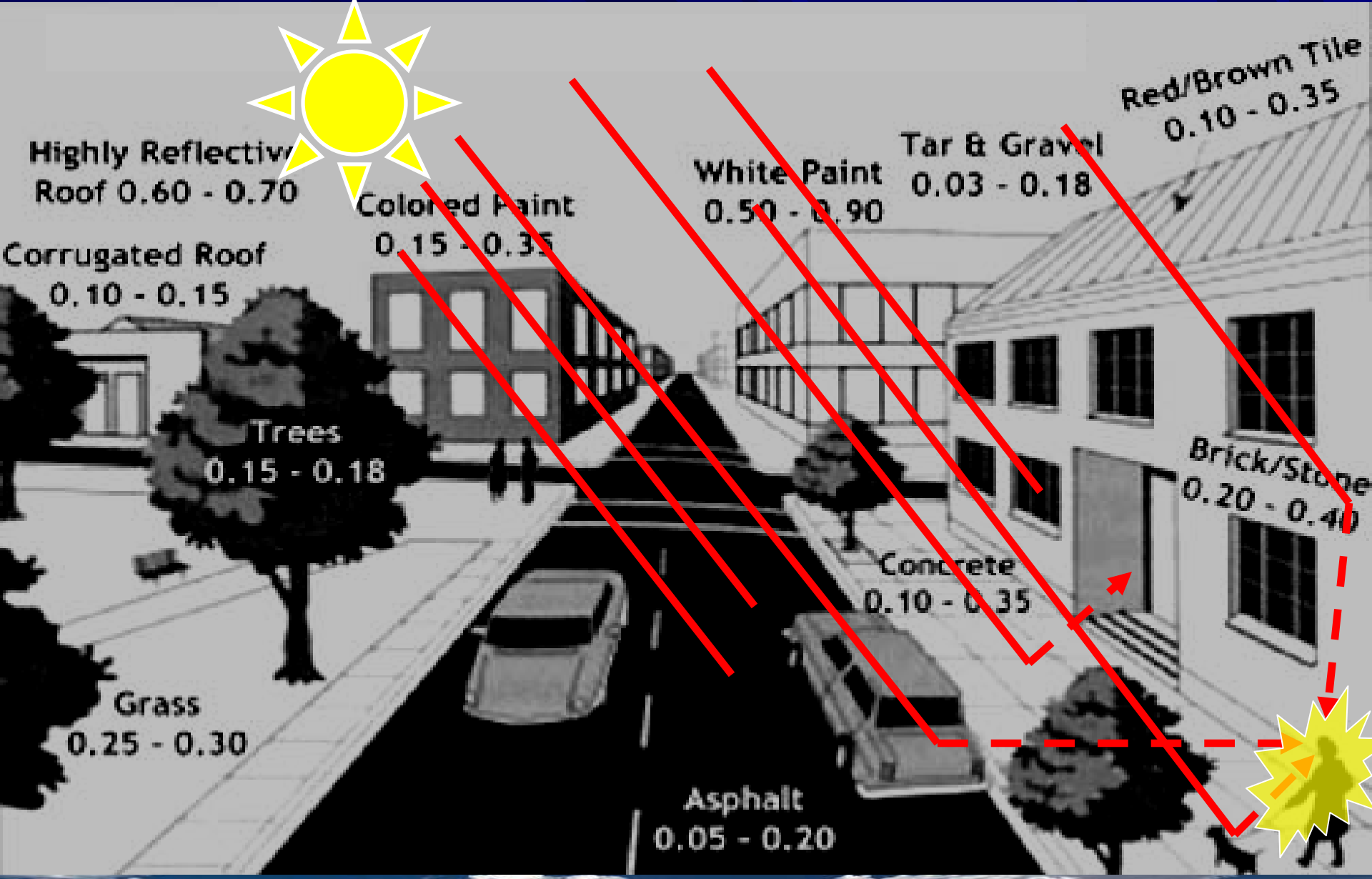

UHI: think about it . . .

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ASPHALT
The Nation's # 1 Recycled Material
recycled pavement
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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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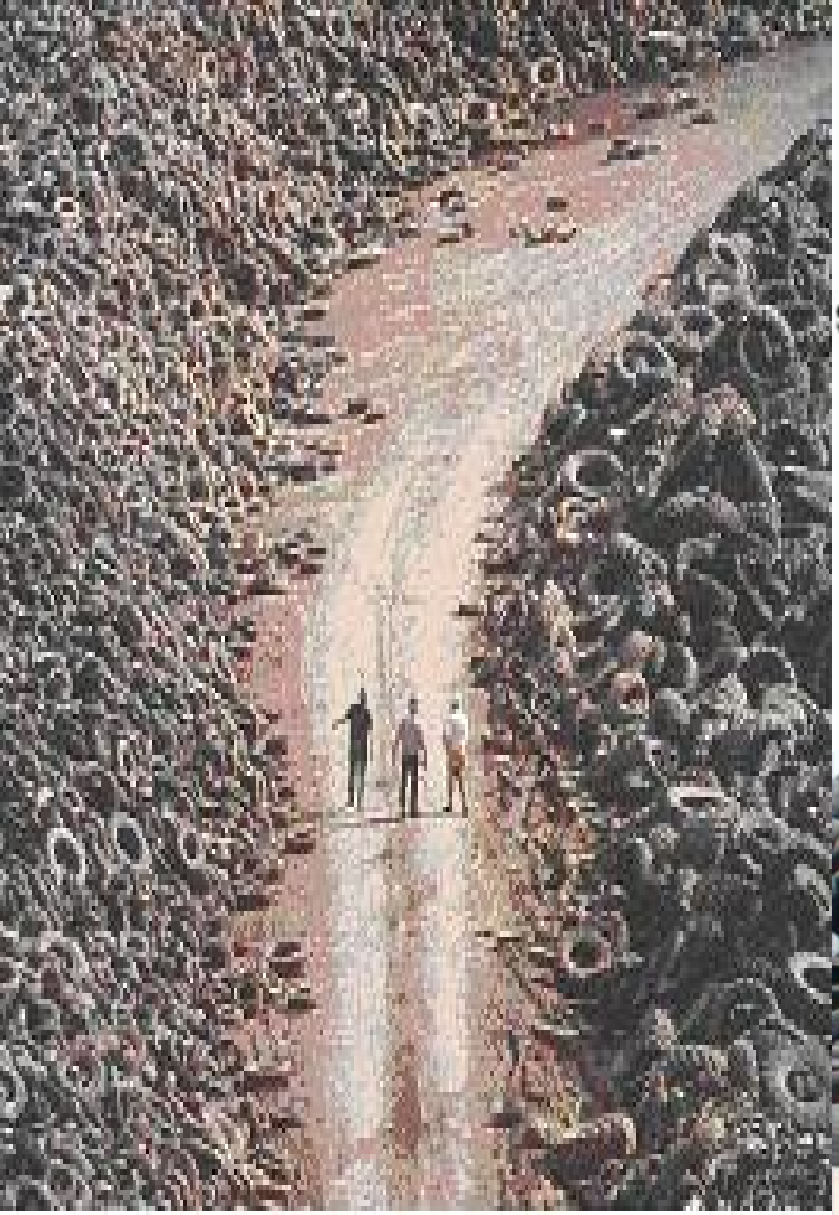

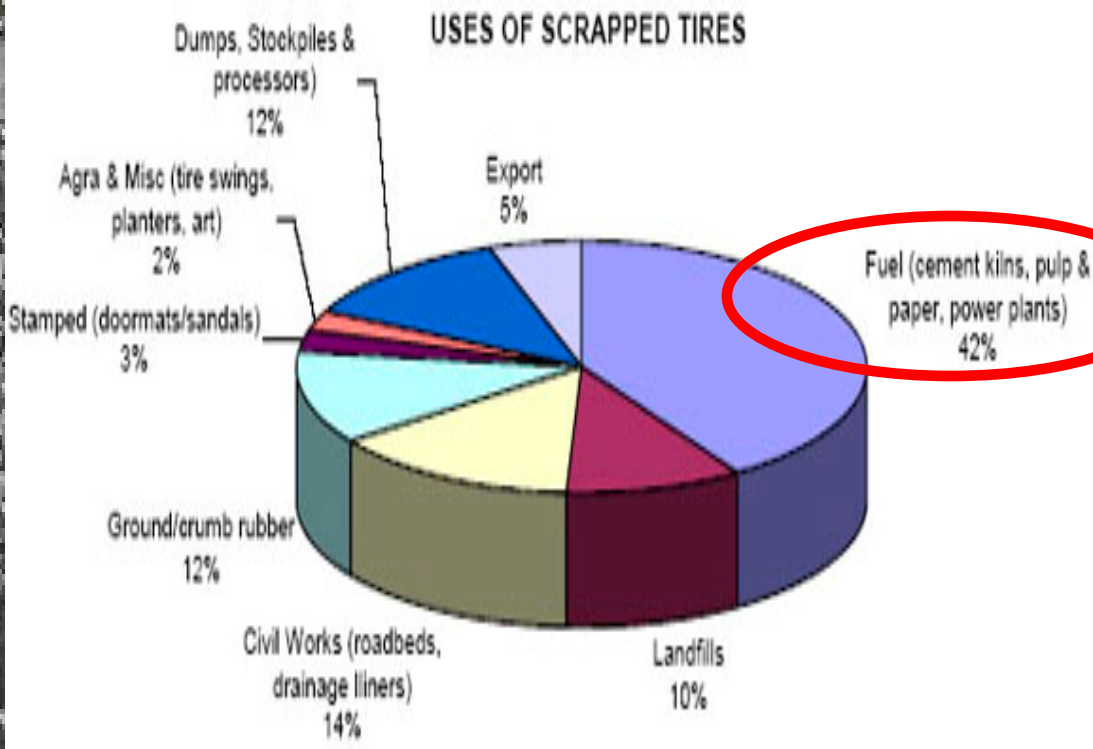
USES OF SCRAPPED TIRES
Dumps, Stockpiles & processors) 12%
Agra & Misc (tire swings, planters, art) 2%
Stamped (doormats/sandals) 3%
Export 5%
Fuel (cement kilns, pulp & paper, power plants) 42%
Ground/crumb rubber 12%
Civil Works (roadbeds, drainage liners) 14%
Landfills 10%


scrap tires
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milling asphalt pavement

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reclaimed asphalt pavement "RAP"

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sizing RAP
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sizing RAP

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processing RAP

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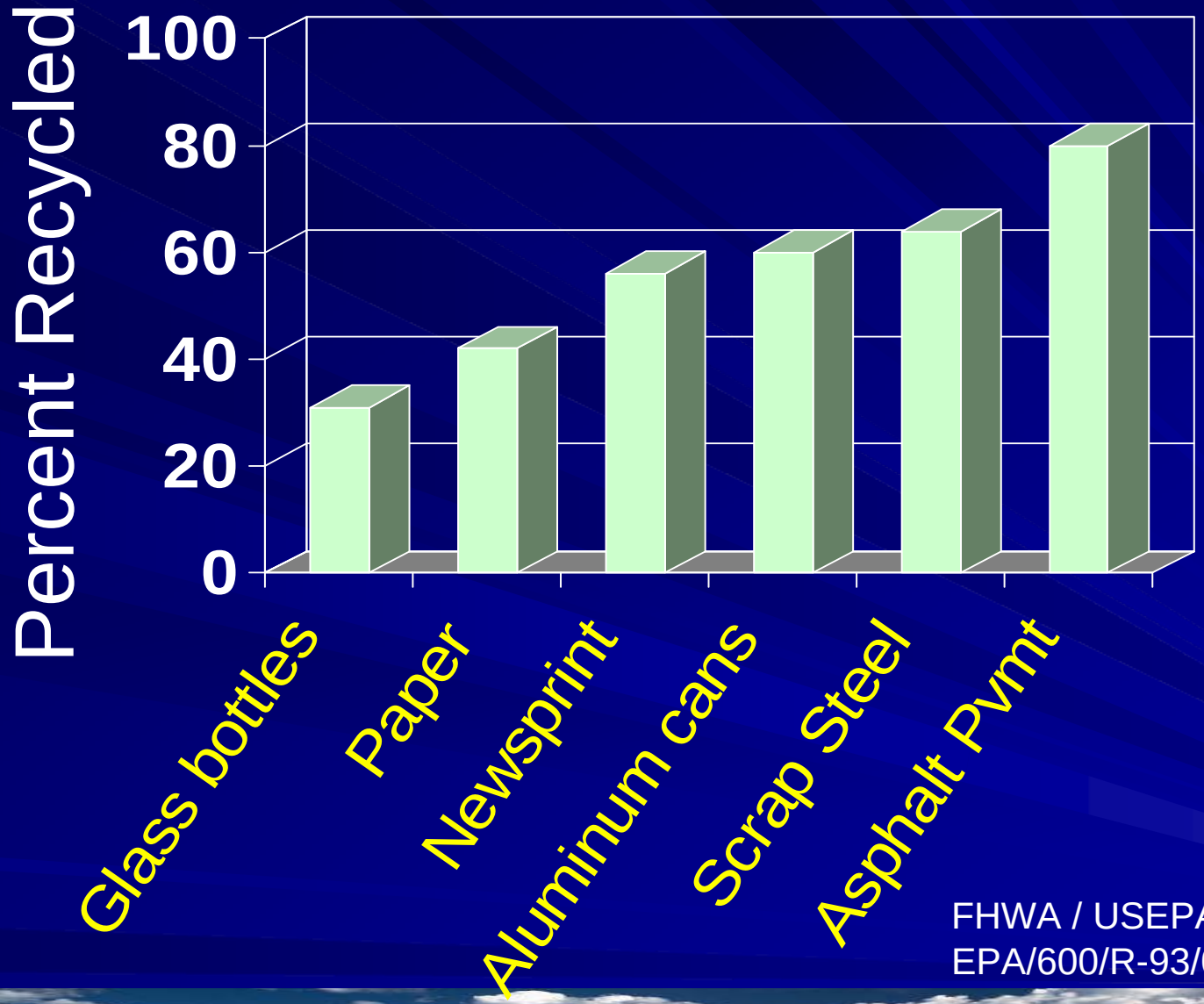
Reclaimed Asphalt Pavement "RAP"

- 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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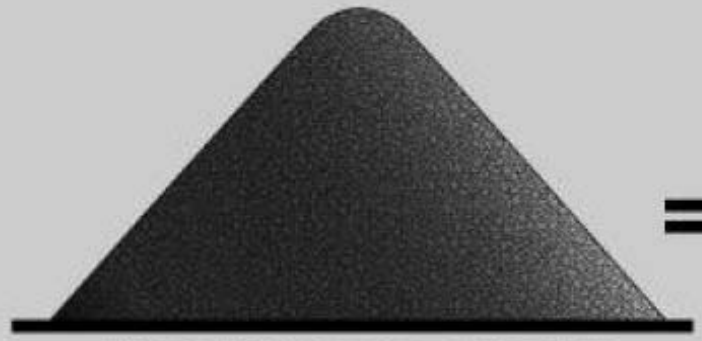
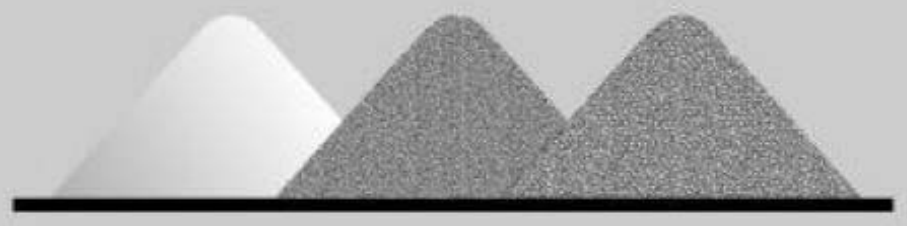


30,000 Tons of RAP

=

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



RAP: sustainable & carbon neutral

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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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USGBC Chapter Awards 2007
LEED: green metrics
NAPA

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.

other green metric programs

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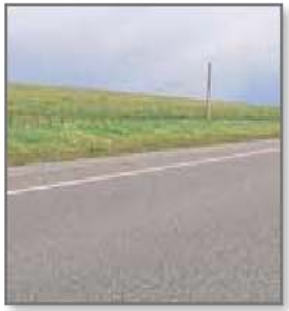
Green Highways Partnership

Stewardship, Safety, & Sustainability

SEARCH:

Home | About | Partnerships | Recognition | Opportunities | Theme Teams | Resources





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.

READ »

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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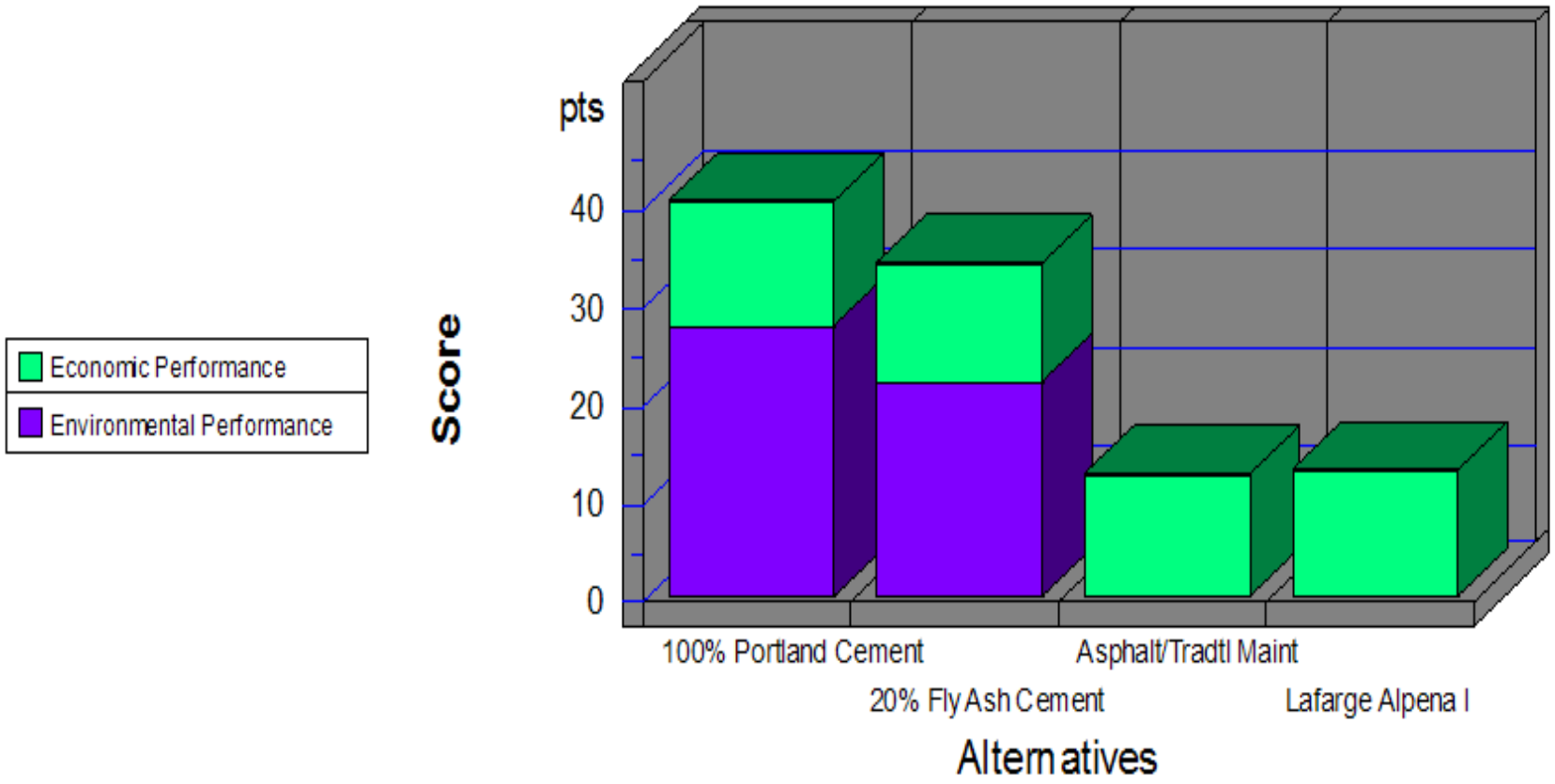
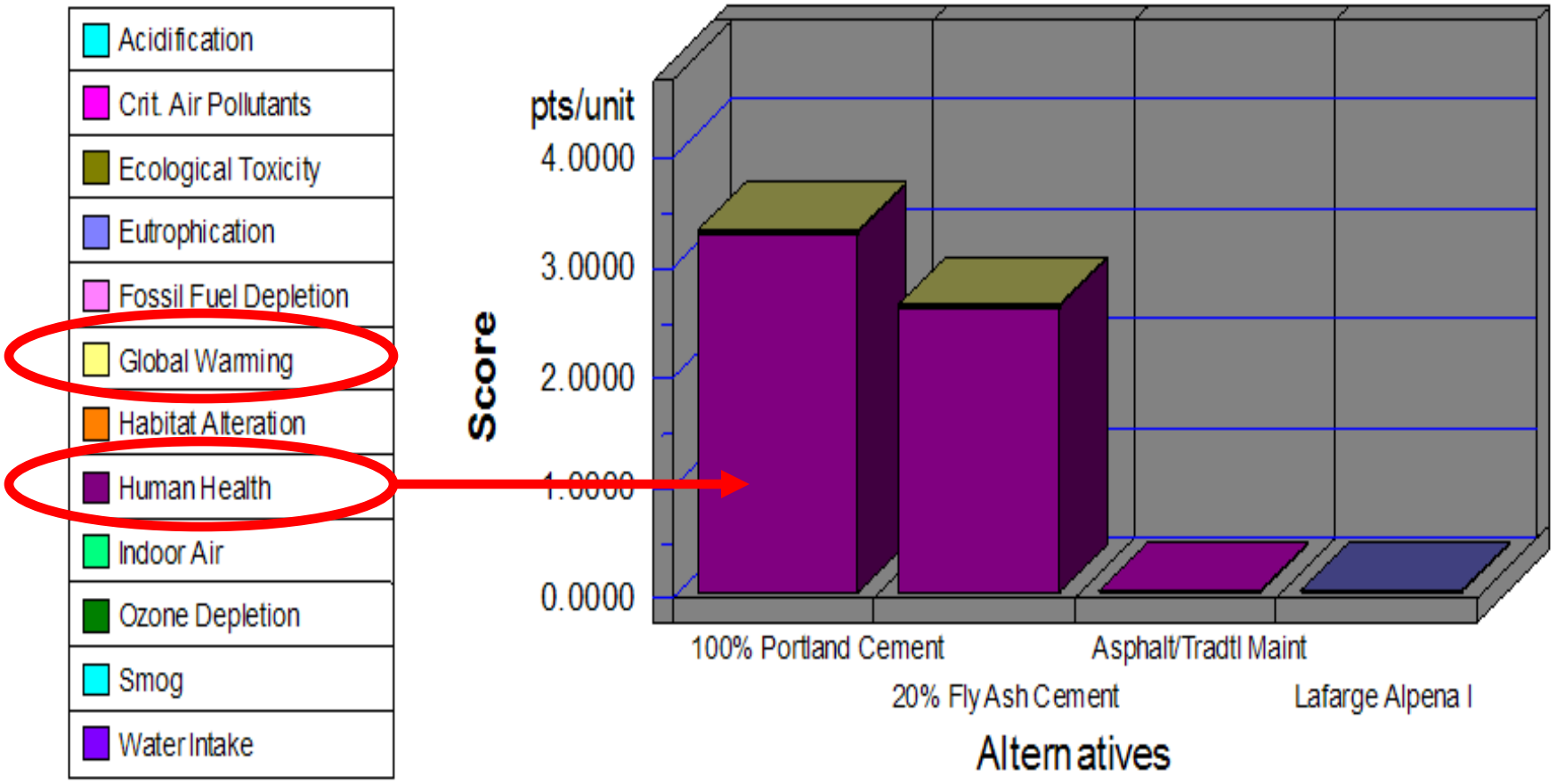
Overall Performance



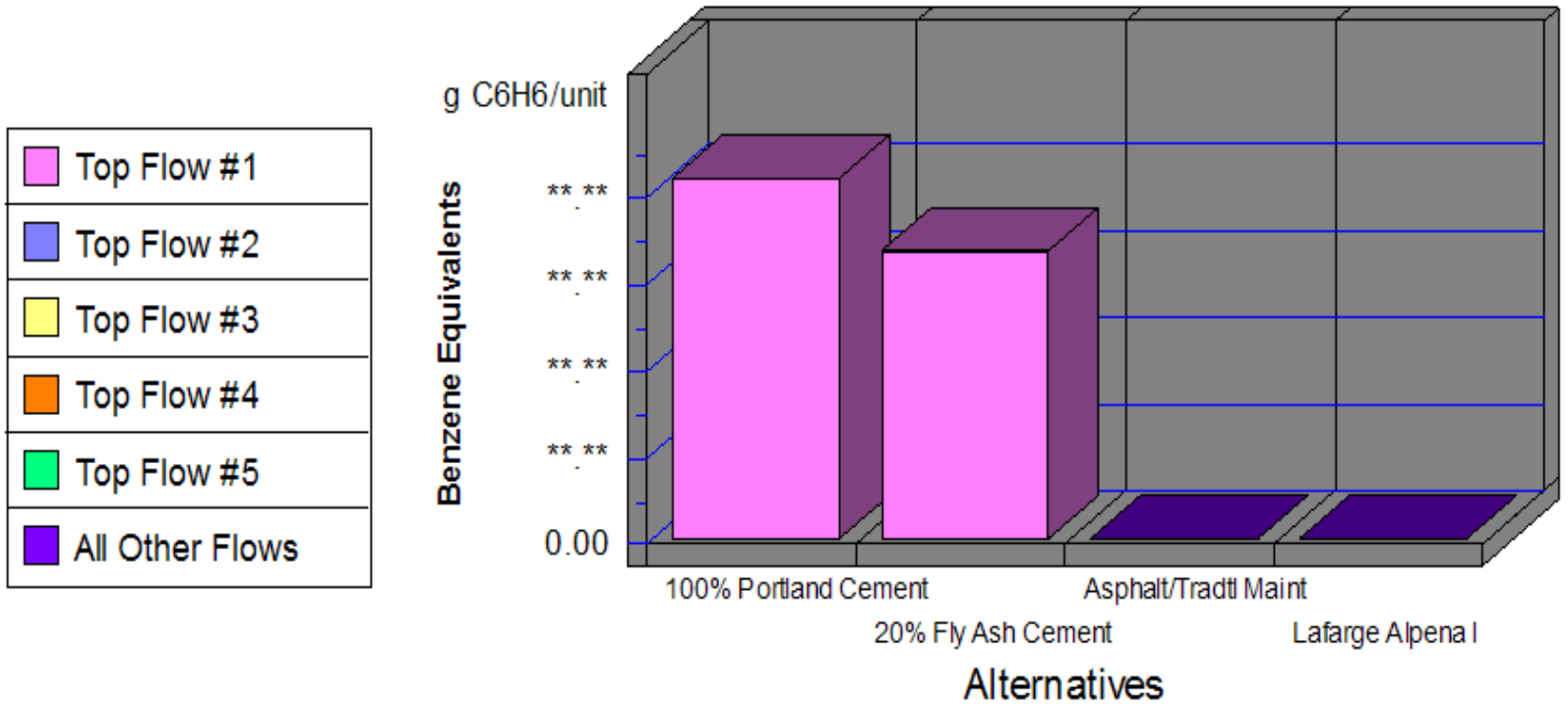
Note: Lower values are better

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
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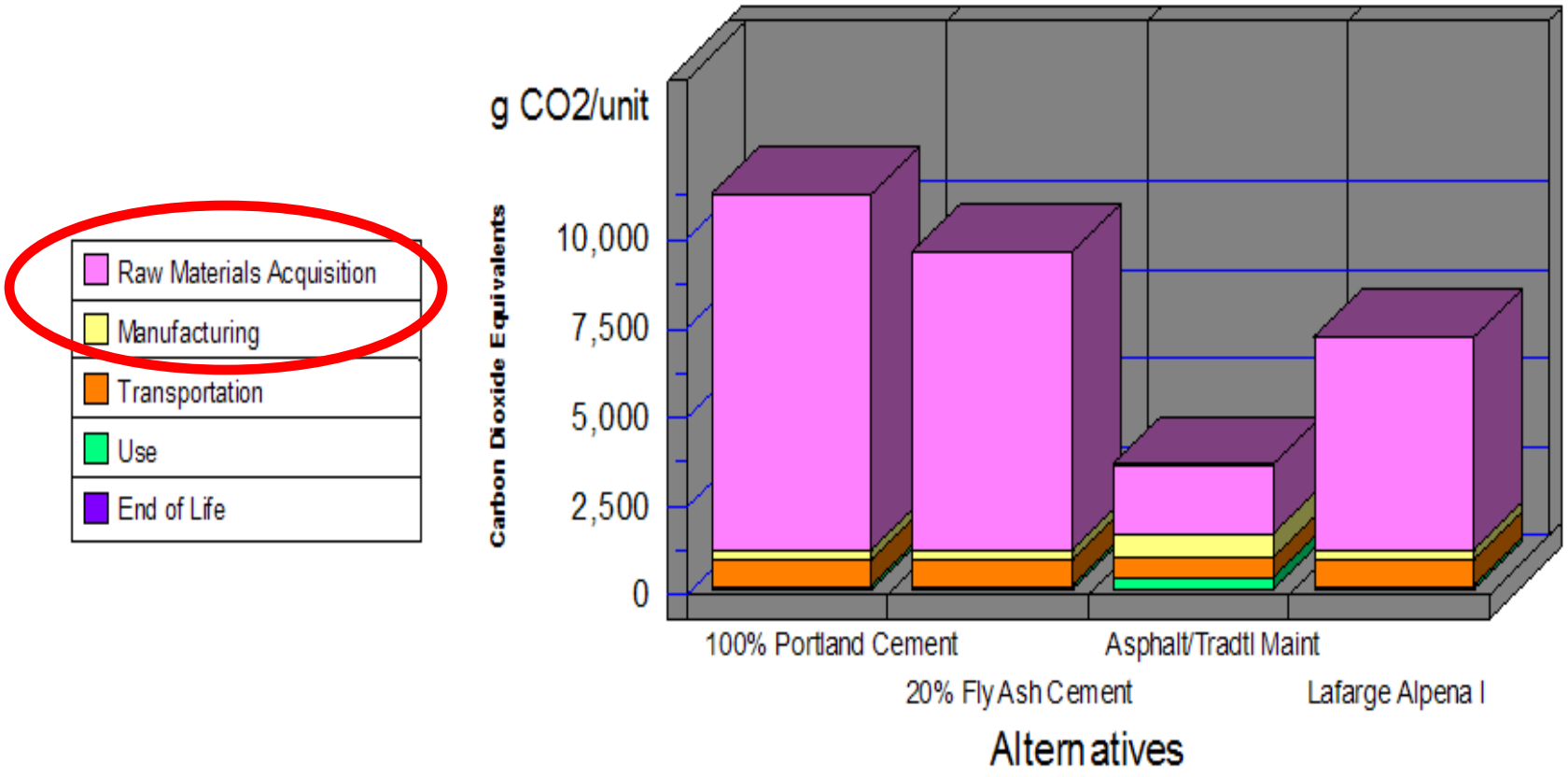
Global Warming by Life-Cycle Stage



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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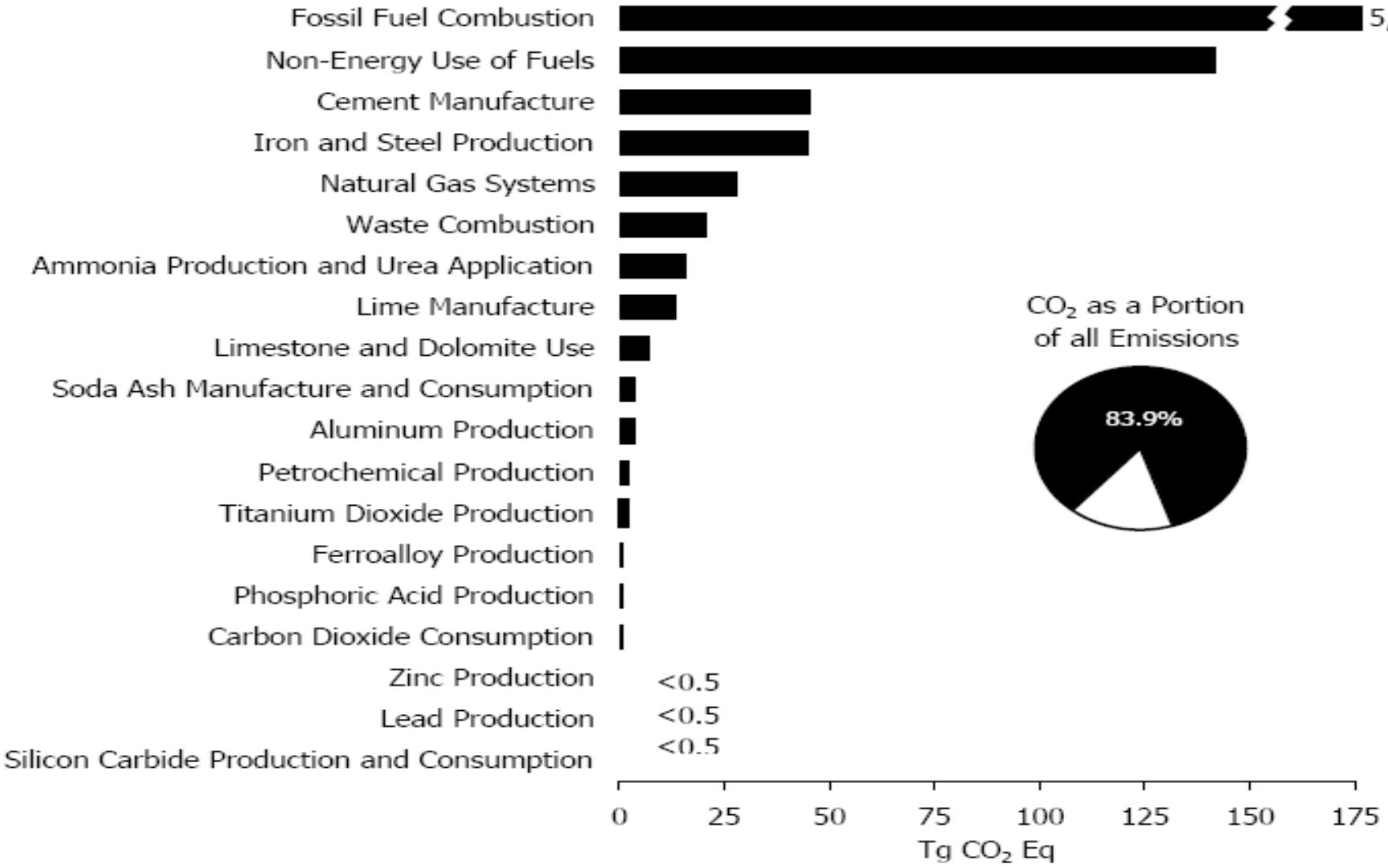


Figure ES-5: 2005 Sources of CO_2

carbon footprint: US sources

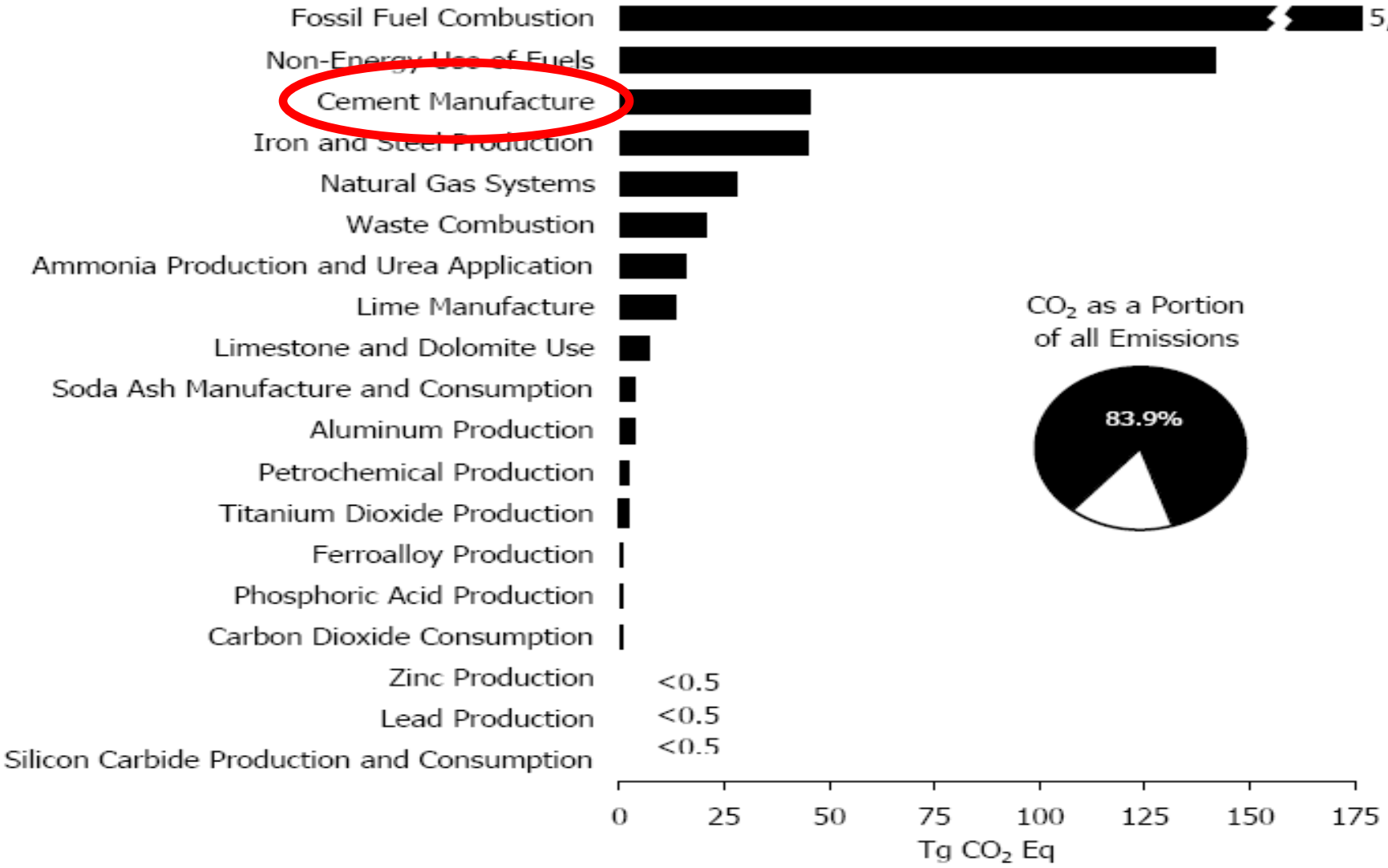


Figure ES-5: 2005 Sources of CO_2

carbon footprint: US sources

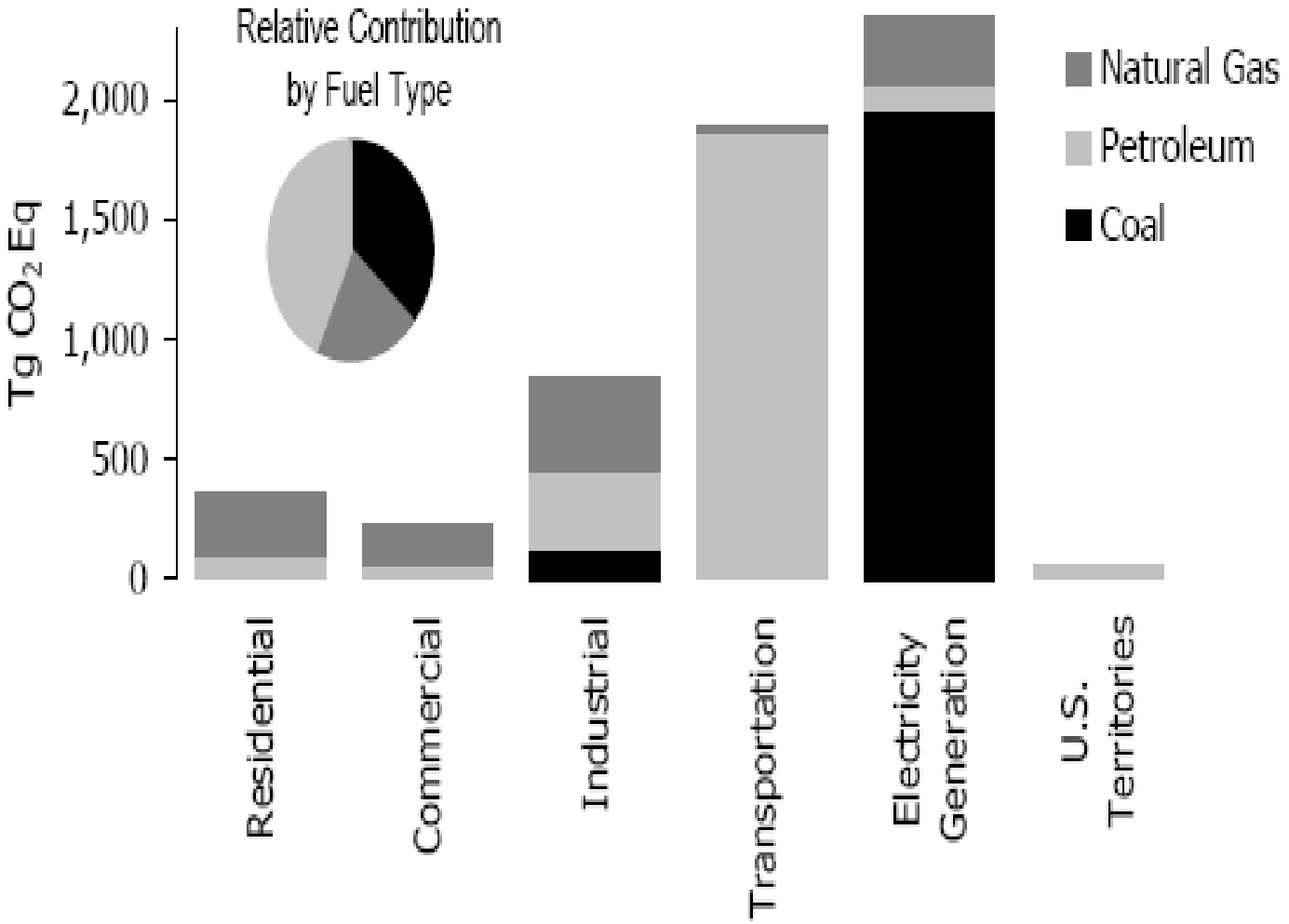
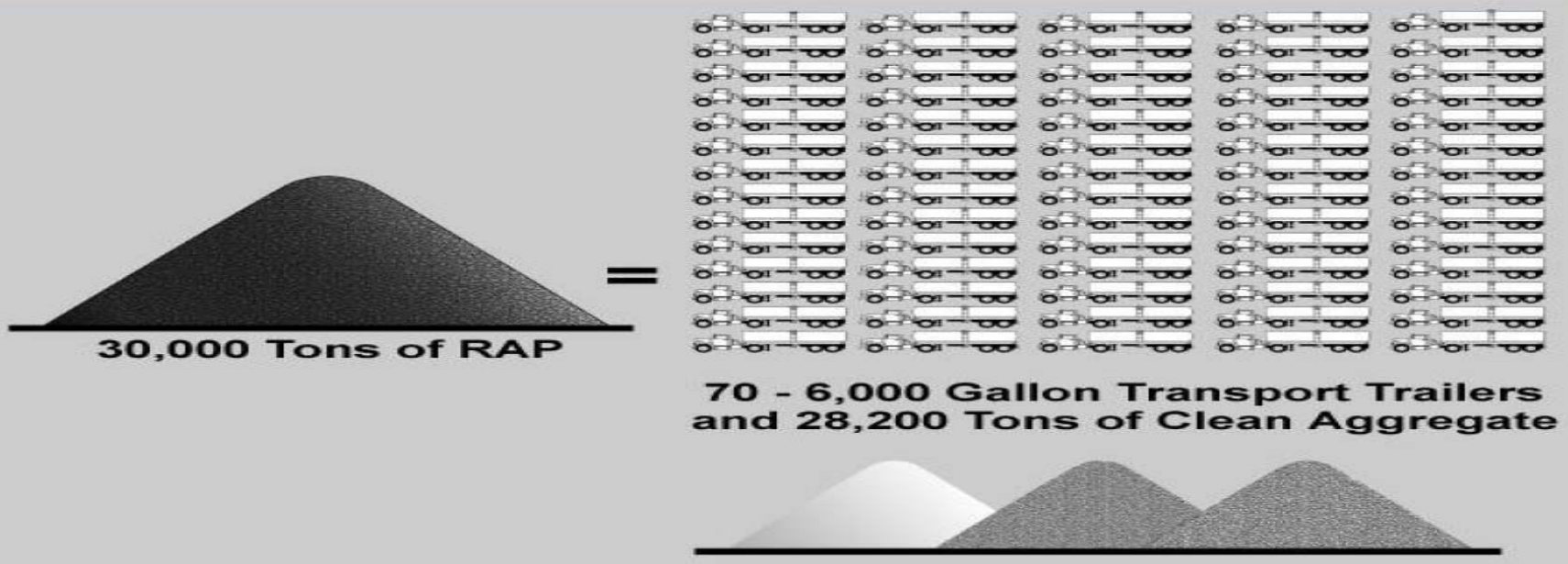


Figure ES-6: 2005 CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type

The entire annual CO2 / greenhouse gas emissions / carbon footprint from a typical hot-mix plant (~ 2,500 tons) could be totally offset by using 20 - 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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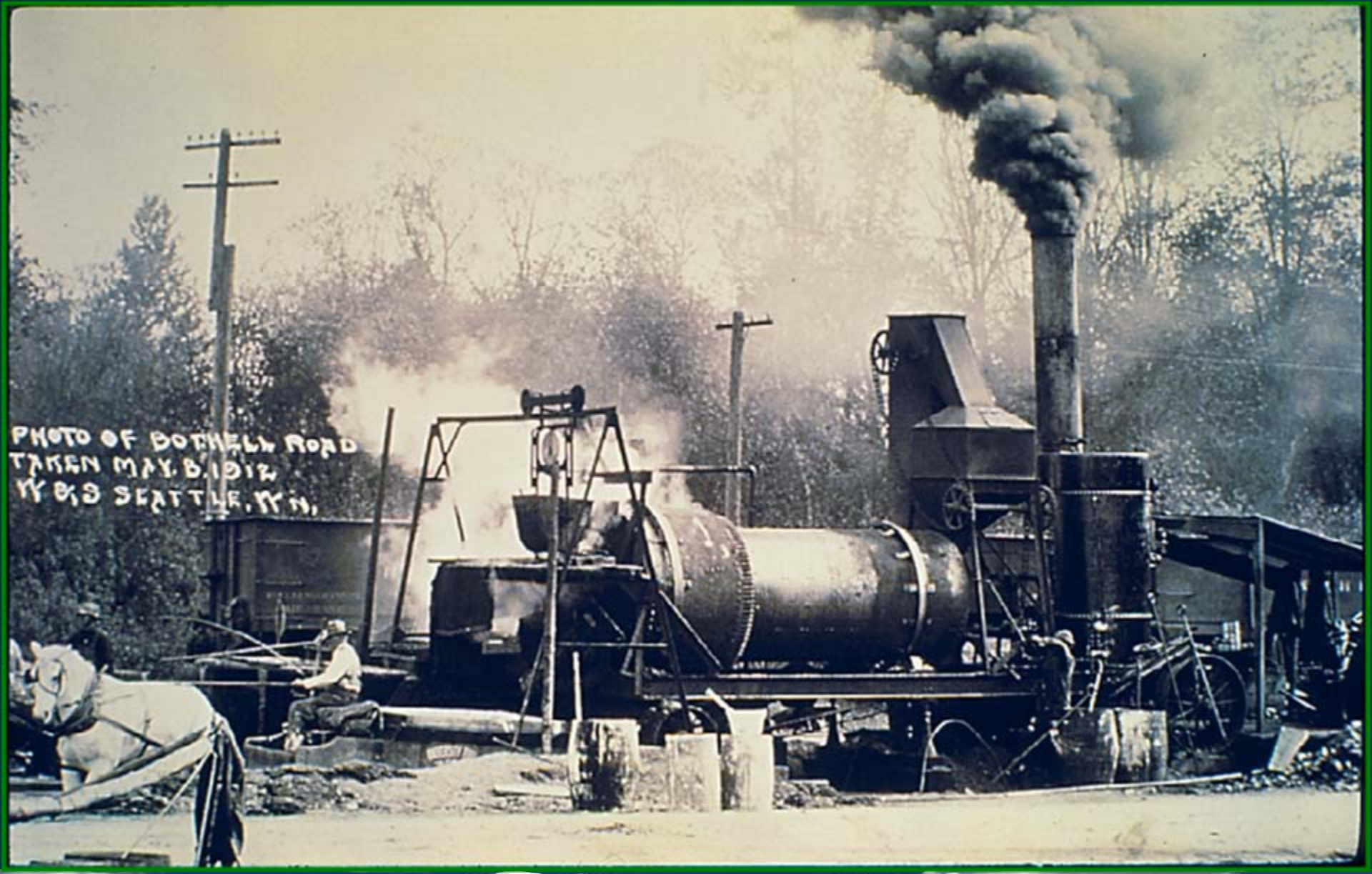

continually changing technology . .

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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 CO2 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

greening the blacktop

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Questions ??

“it ain’t easy being green!”

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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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