

think fresh





# better roads ahead

*Sustainable solutions to complex transportation needs*

**FEATURING**

**David McLean**, Professor and Chair,  
Civil and Environmental Engineering,  
College of Engineering and Architecture

**Curtis Hinman**, Associate Professor,  
WSU Pierce County Extension  
Director, WSU Low Impact Development Research Program  
Watershed Ecologist

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April 6, 2010  
Seattle



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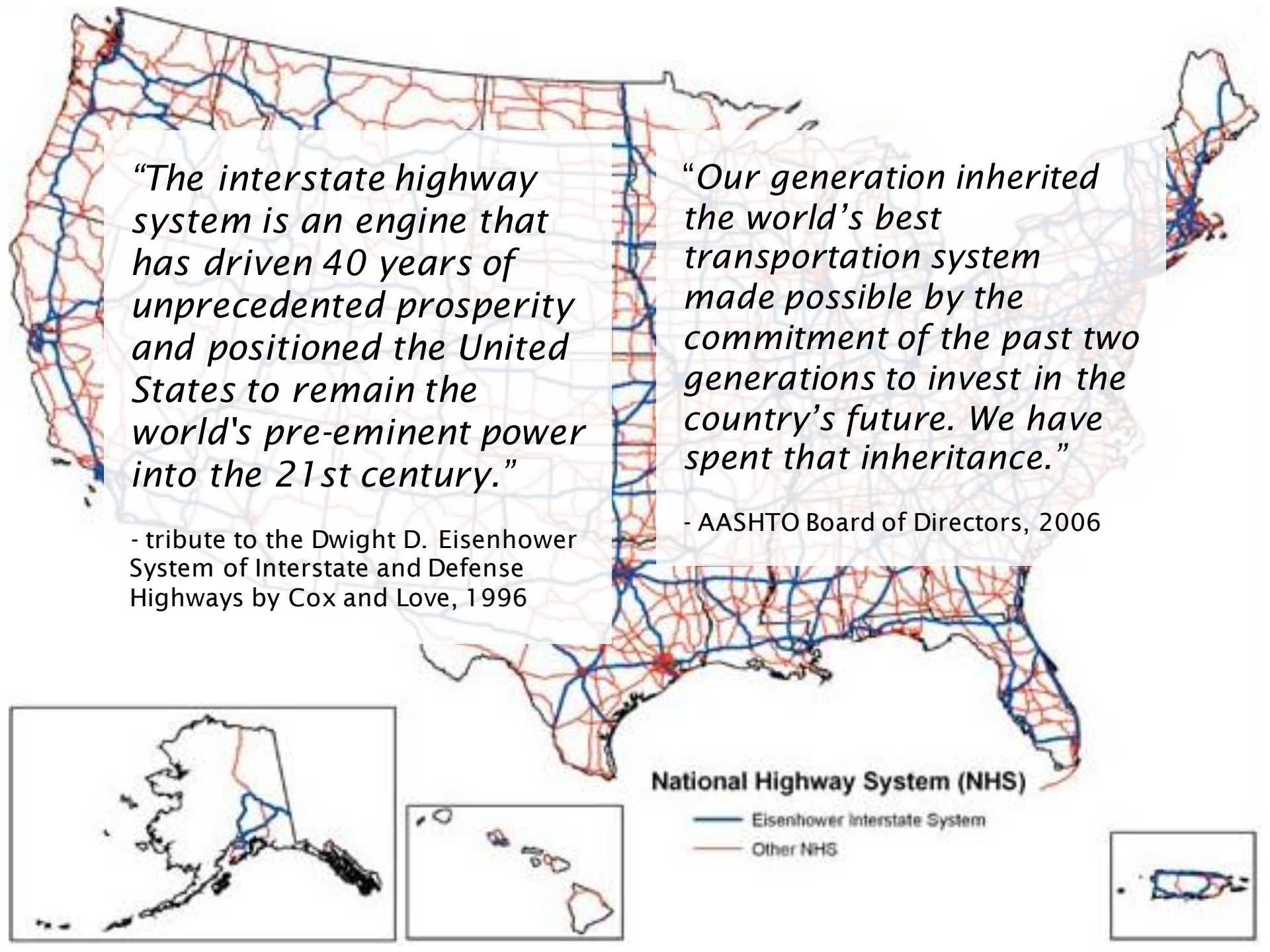


# SUSTAINABILITY

- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.



*UN World Commission on Environment and Development  
Brundtland Commission Report, 1987*



*"The interstate highway system is an engine that has driven 40 years of unprecedented prosperity and positioned the United States to remain the world's pre-eminent power into the 21st century."*

- tribute to the Dwight D. Eisenhower System of Interstate and Defense Highways by Cox and Love, 1996

*"Our generation inherited the world's best transportation system made possible by the commitment of the past two generations to invest in the country's future. We have spent that inheritance."*

- AASHTO Board of Directors, 2006

#### National Highway System (NHS)

— Eisenhower Interstate System  
— Other NHS



A photograph of a large steel truss bridge, likely a suspension or cantilever bridge, showing the intricate steel framework. A worker in a high-visibility vest is visible on a platform or scaffolding near the bottom right. A "CAUTION" sign is visible on the upper part of the bridge structure.

**\$500 billion: cost to eliminate  
backlog of needed repairs  
and improvements to current  
highway and bridge network**

– US DOT, 2009

# Growing Challenges

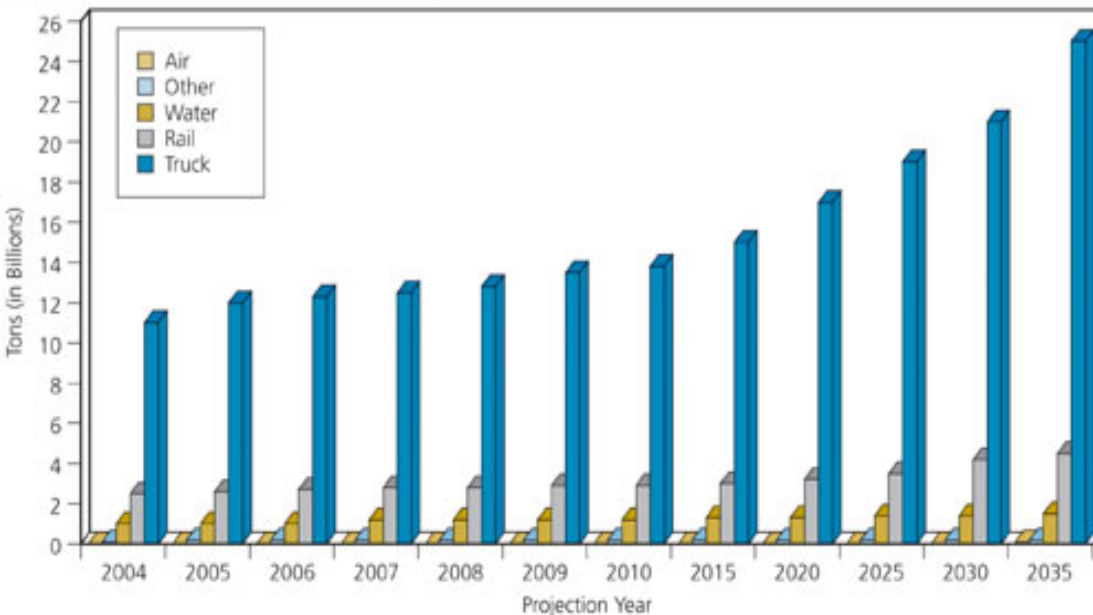
U.S. Population

Number of Vehicles in the U.S.

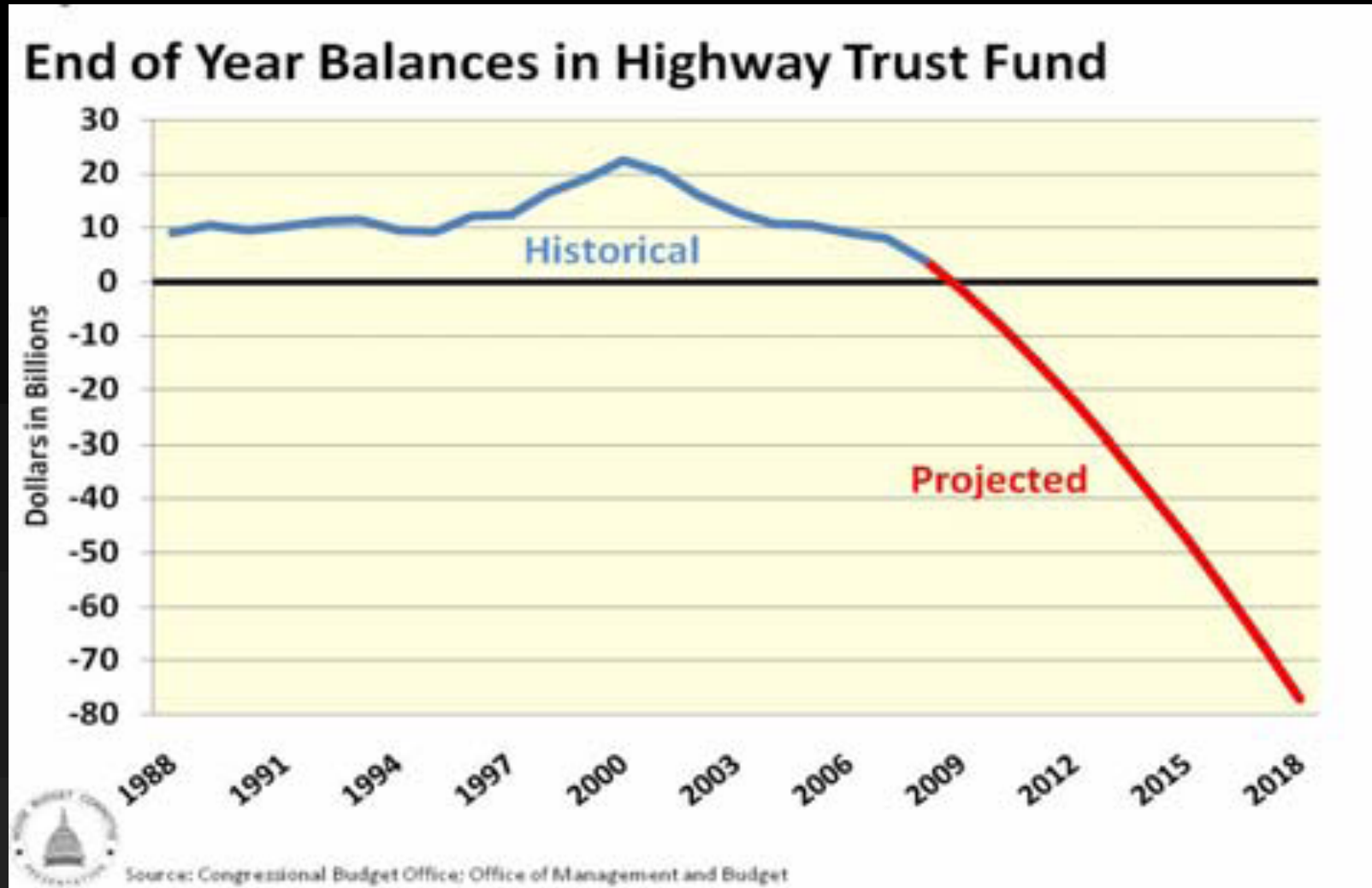
Miles of Travel in America

The U.S. will require twice as much arterial highway capacity over the next 50 years as was built over the last 50 years.

Projected Freight Ton Growth by Mode, 2004–2035



# Highway Trust Fund Broke






# Puget Sound Partnership

our sound, our community, our chance





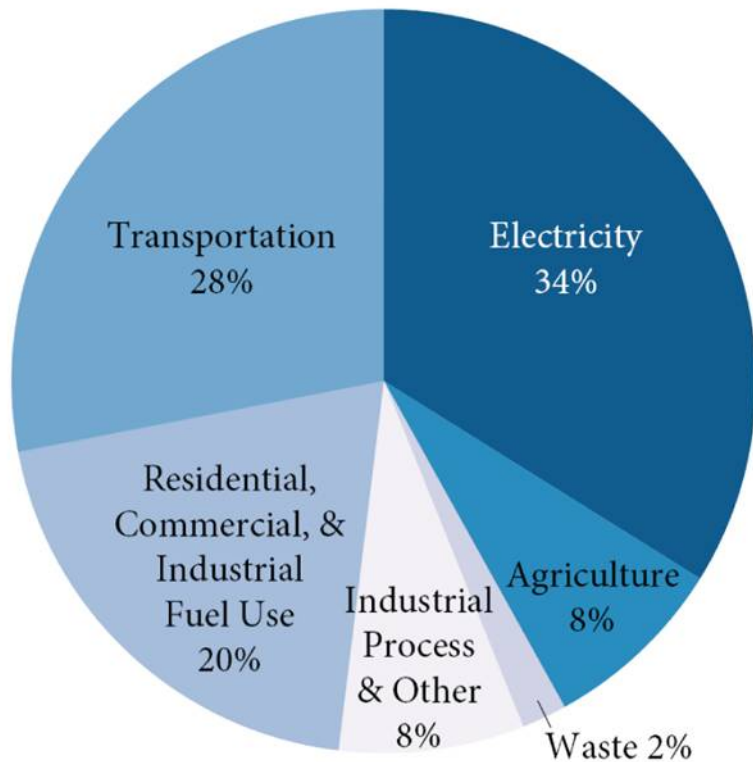
An aerial night photograph of a city, likely Seattle, showing a large, brightly lit stadium in the center. Surrounding the stadium are multi-lane highways filled with cars, their headlights and taillights creating a dense pattern of light. The city's lights are visible in the background, creating a bokeh effect against the dark sky.

Seattle: 30 minutes average daily commute  
45 hours average annual traffic delay

U.S.: 3 billion gallons of gas wasted and  
\$80 billion cost each year due to traffic  
congestion

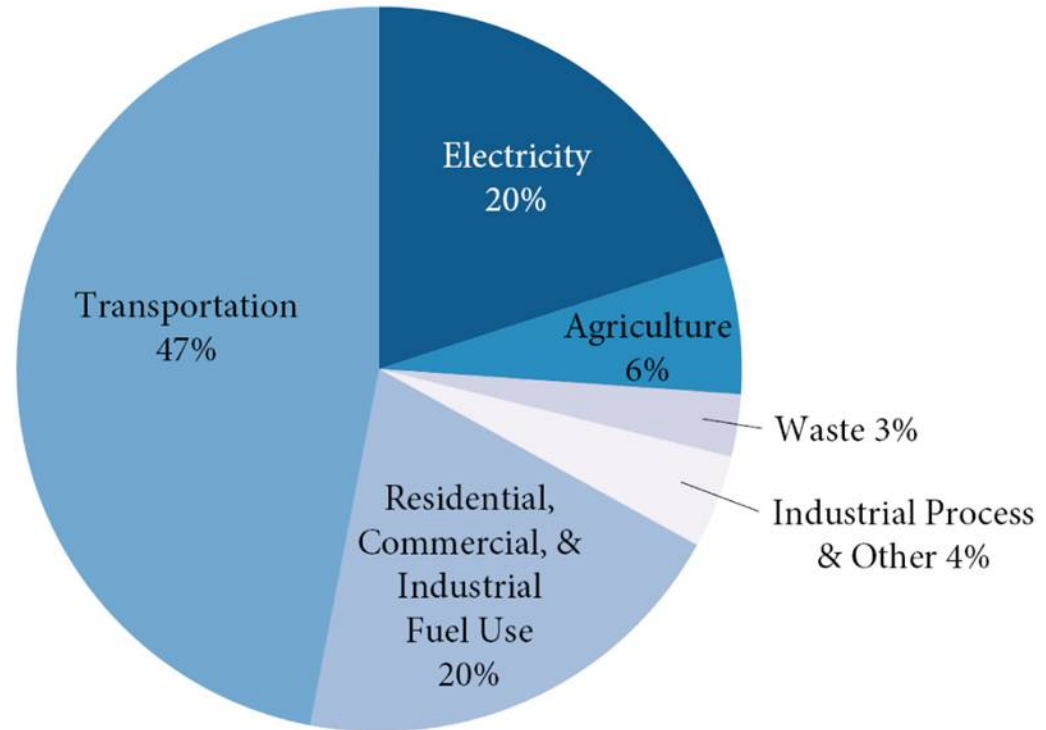
# Transportation's Contribution to GHG

U.S. Greenhouse Gas Emissions



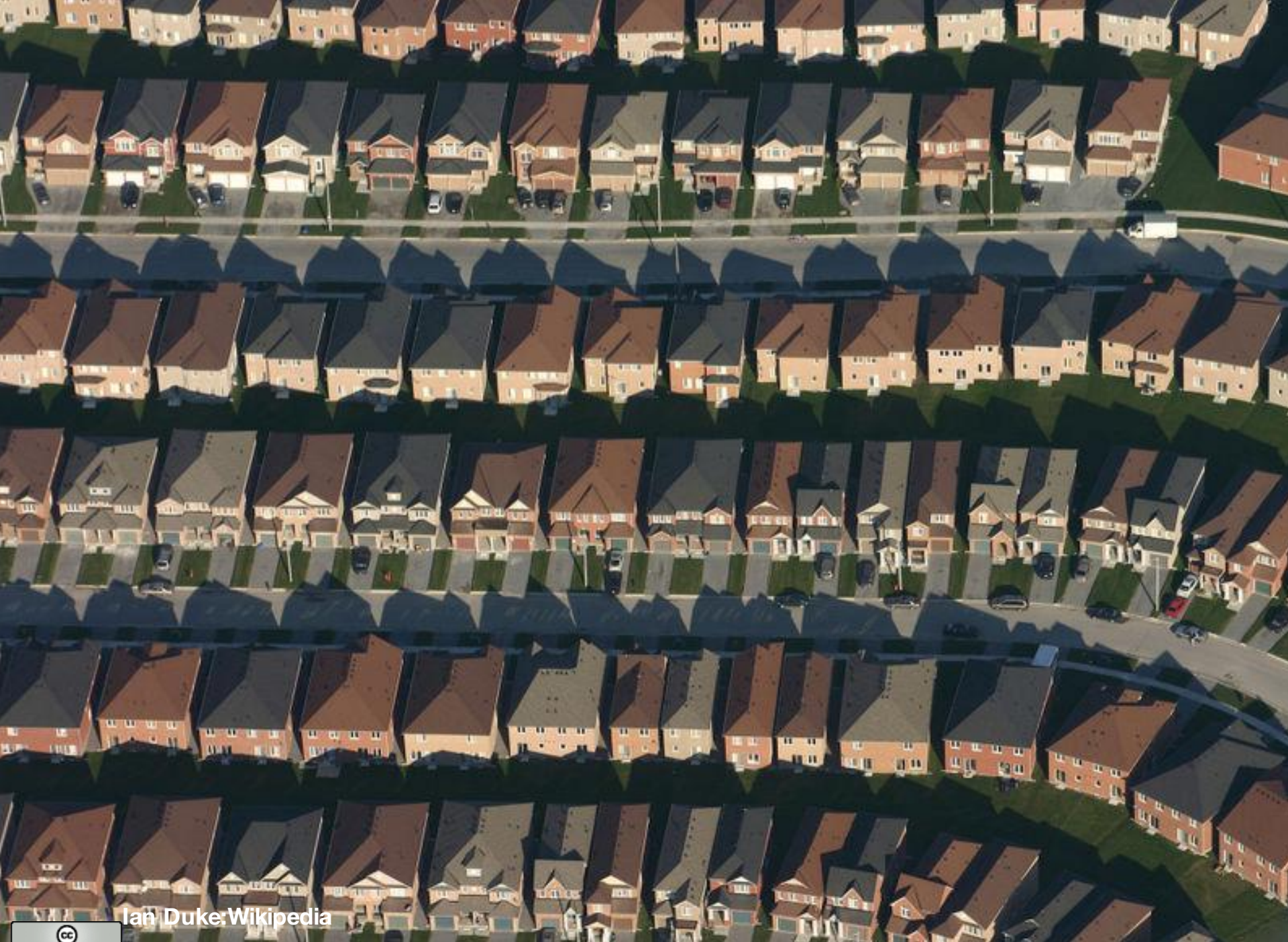
Source: Washington State Department of Ecology, 2005

Washington Greenhouse Gas Emissions



Source: Washington State Department of Ecology, 2005





Ian Duke Wikipedia



SOME RIGHTS RESERVED

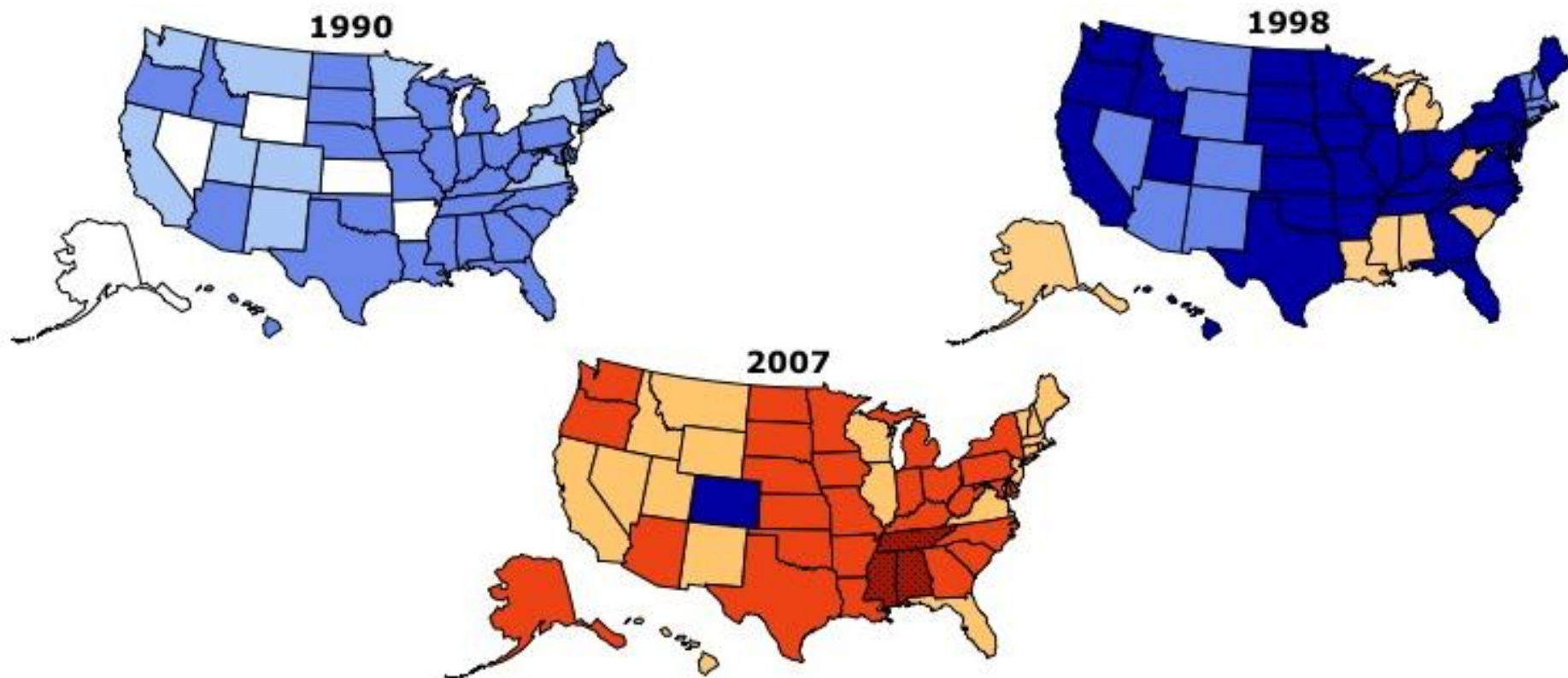




# Obesity Trends\* Among U.S. Adults

## BRFSS, 1990, 1998, 2007

(\*BMI  $\geq 30$ , or about 30 lbs. overweight for 5'4" person)



Source: CDC Behavioral Risk Factor Surveillance System.

# SUSTAINABILITY

Moving people and freight in an environmentally and economically sustainable manner will be one of the biggest challenges of the 21st century.



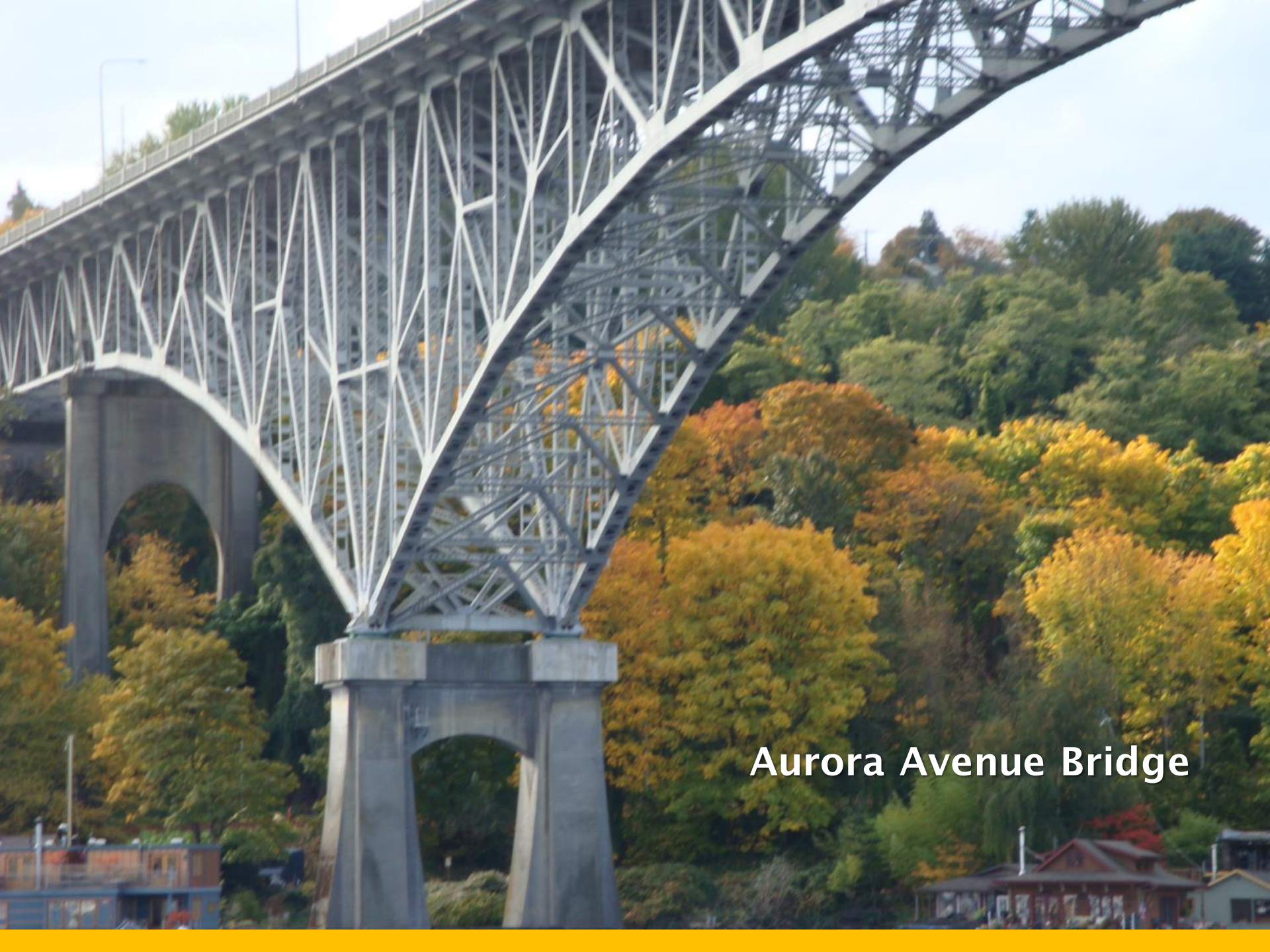
Source: International Organization for Economic Cooperation and Development  
Transportation Futures, Strategies and Best Practices 2000

# Solutions for a Sustainable Future

1. Preserve what has been built
2. Improve current system performance and efficiency
3. Better integrate transportation planning and land use
4. Increase multimodal transportation options
5. Create funding mechanisms to make improvements and add capacity
6. Reduce impact of transportation on the natural environment

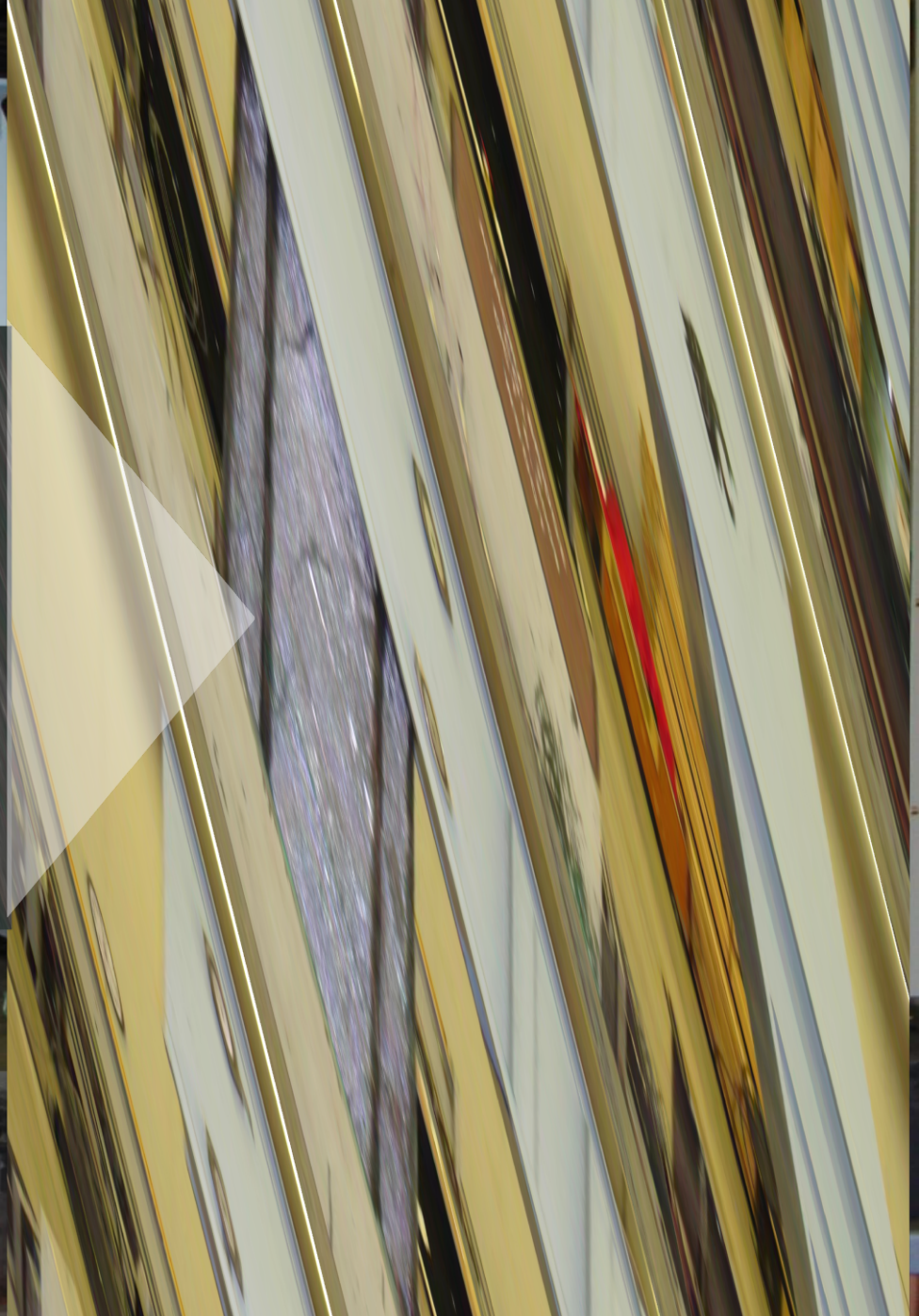
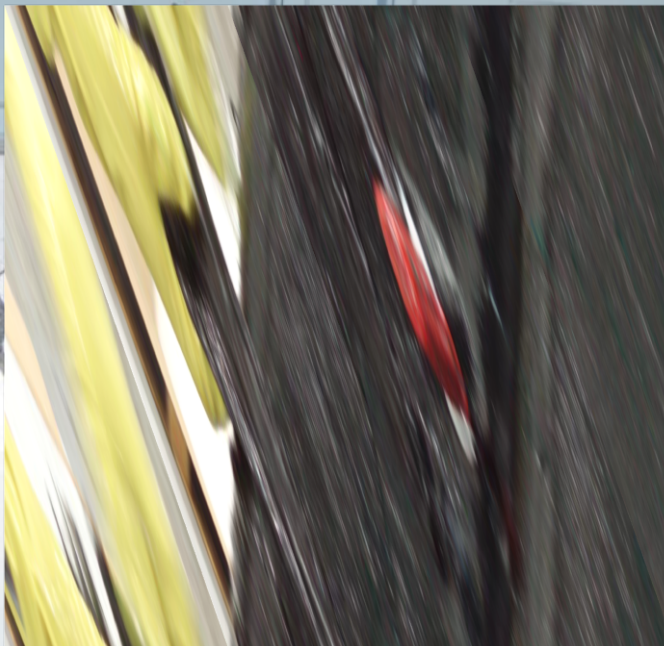






**Aurora Avenue Bridge**

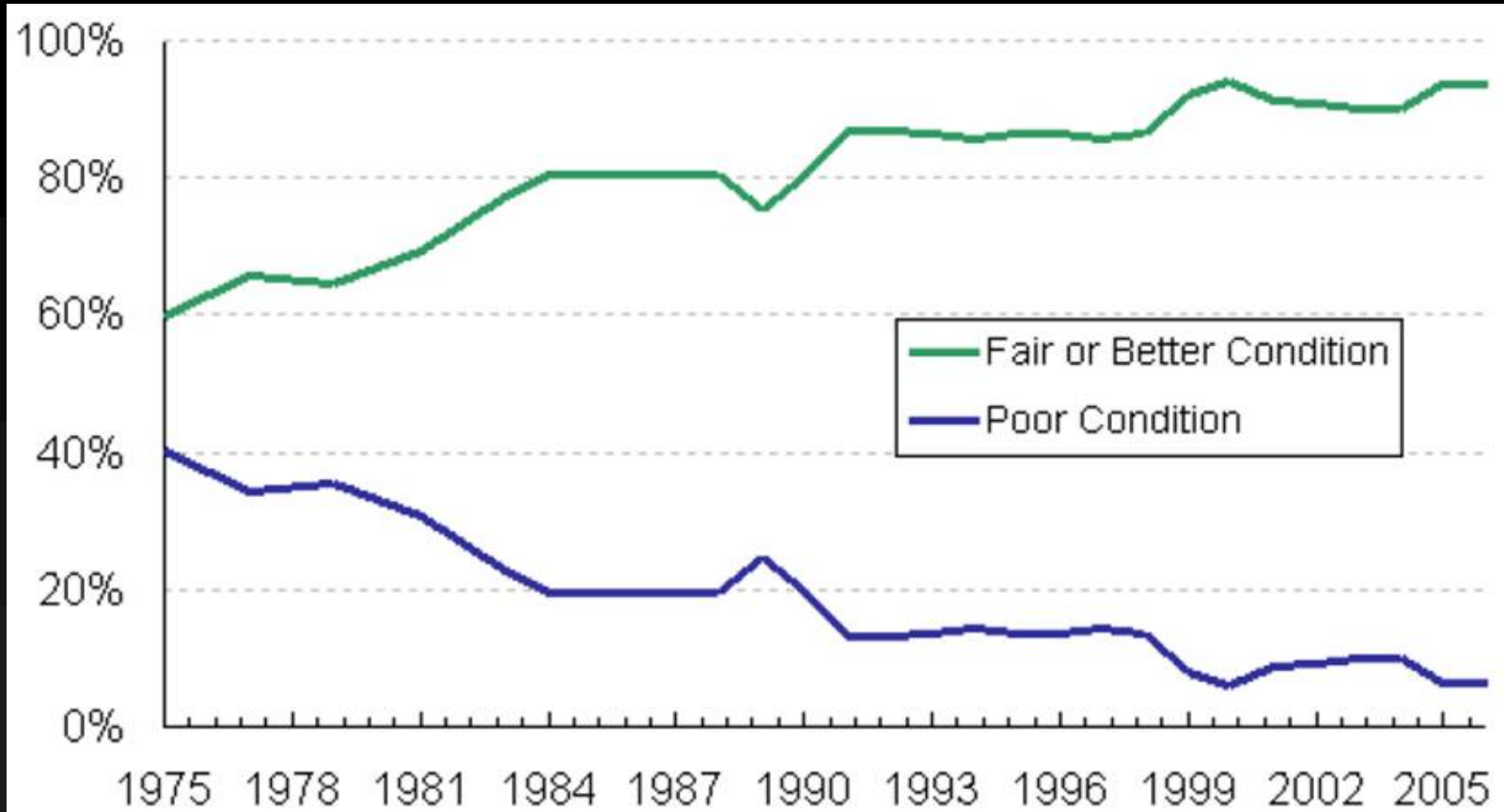








# State Highway Pavement Trends (1975-2007)



Research supporting WSDOT's pavement management program has resulted in better roads and more than \$100 million in savings over the last 10 years for the state



Website: [www.sfta.wsu.edu](http://www.sfta.wsu.edu)

# Wireless Connectivity Enabling Smart Transportation Systems



Drivers



Vehicles



Infrastructure



Wireless  
Devices







King County Executive Ron Sims, a leader in healthy community design, commutes to work on his bike.



King County

# HealthScape

*Community design for health and the environment*

## ***Case study: SW 98th Street corridor***

**H**ealthScape principles can be applied to planning processes in urban, suburban, and rural communities. For example, King County has incorporated findings from the LUTAQH study into planned improvements to the SW 98th Street corridor in White Center. Enhancements to sidewalks and the streetscape along the main commercial corridor will complement a new trail connection to the nearby Greenbridge development. In addition, the new Development Impact Assessment Tool will be used to evaluate proposed zoning changes in the neighborhood.

To learn more about this and other projects in King County, visit the HealthScape Web site (see address below).

## **Learn more/ participate**

**H**ealthScape is a dynamic project that draws on the participation of residents, planners, public health officials, advocates, elected officials, and many others. It will continue to rely on wide participation to help refine the tools now being developed, and you can be a part of this process.

For more information, please visit our Web site (see address below) or contact Christina O'Claire ([christina.oclaire@metrokc.gov](mailto:christina.oclaire@metrokc.gov), 206-263-4753).

# **Sustainability through healthy community design**





# Multimodal Systems as Alternatives to Driving



# New Funding Basis Needed



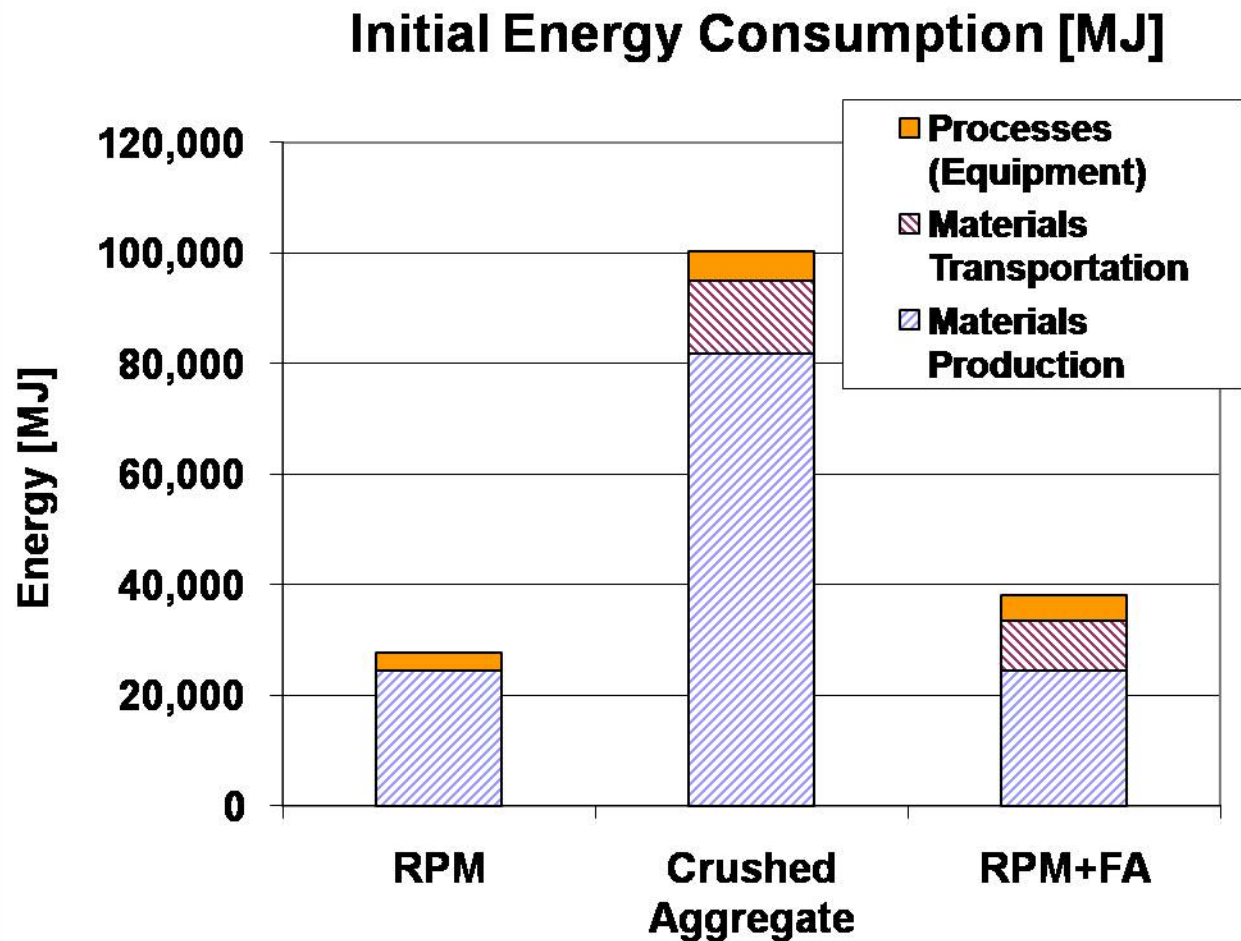
- Fuel taxes not enough
- Taxes based on vehicle miles traveled (VMT)
- Increased use of toll roads and toll lanes along with congestion-based pricing
- Public–private partnerships as well as fully private
- Expanded funding for transit

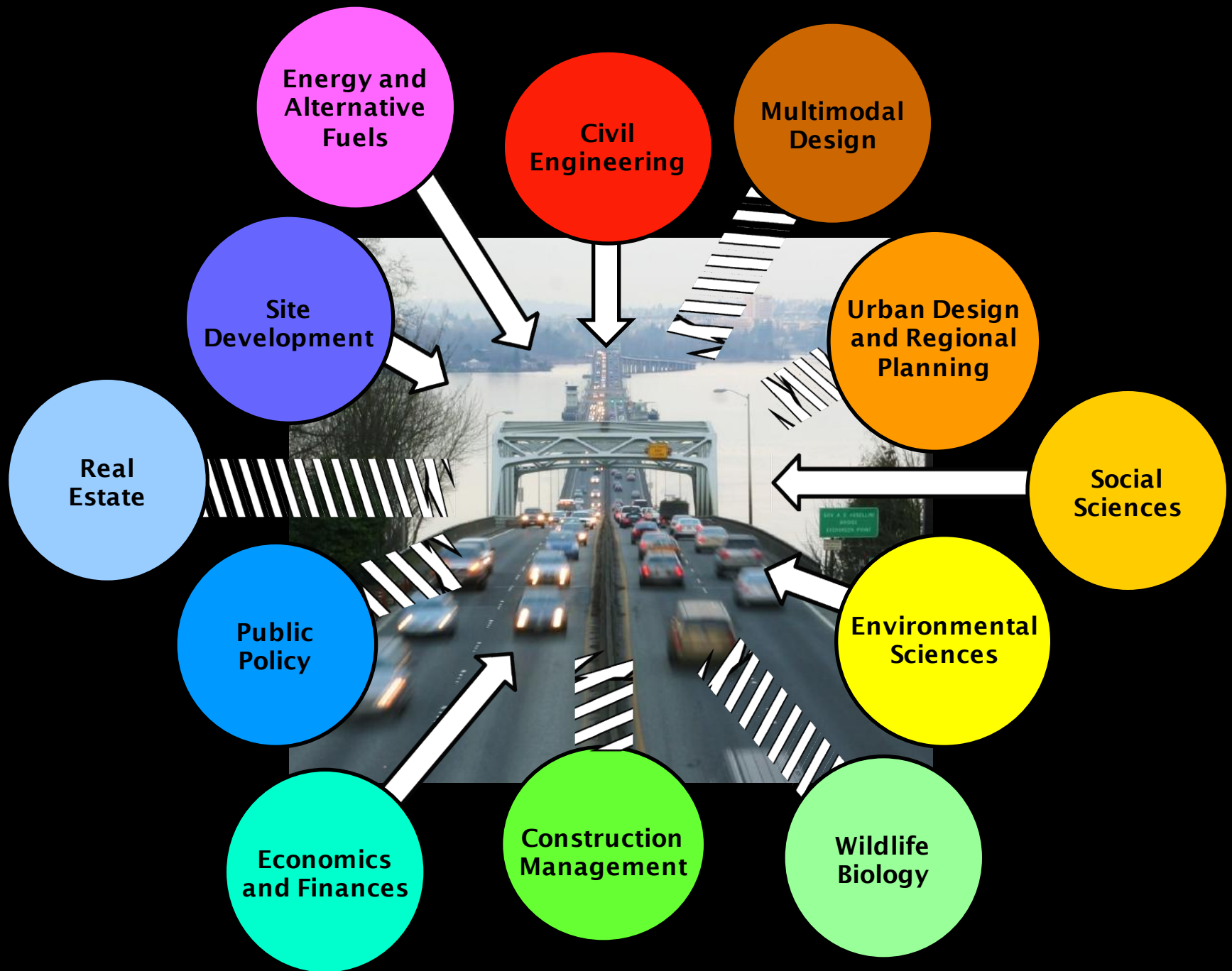
# Improved Standards for Design and Construction





# Use of Recycled Materials





# IDeX

Integrated Design Experience

**Mission:** To pioneer and catalyze changes to the design and construction of the built environment that facilitate a sustainable future.

The Integrated Design Experience incorporates real project and joins students from engineering and the allied design disciplines with practitioners and faculty working together to develop sustainable solutions for the built environment.

The **smartFARM** project is designing an organic farm that is both water and energy neutral. It will influence policy and outline a new blueprint for the production and consumption of food, energy, and water.

## ANAEROBIC DIGESTER AND GREENHOUSE BENEFITS

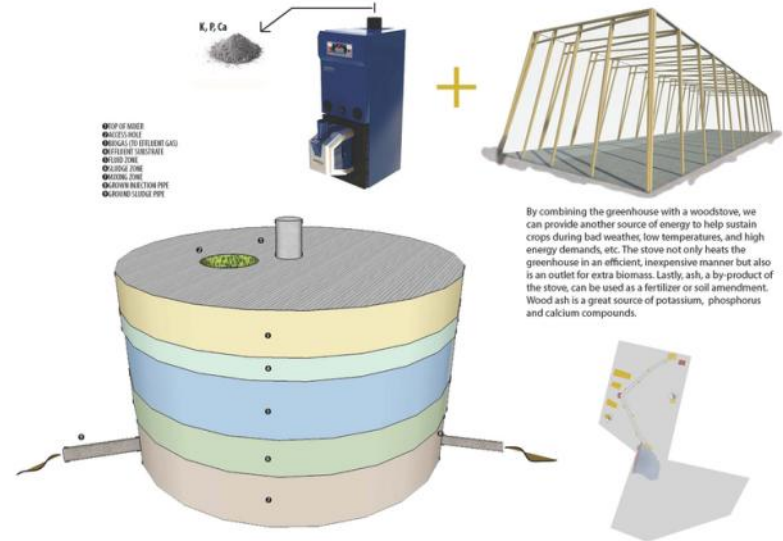
BIOMASS/ WOOD STOVE COMBINED WITH GREENHOUSE SYSTEM

### GREENHOUSE BENEFITS

- Allows for year-round growing
- On-site transplant storage
- Provides an alternative heat source for occupants and any nearby structures
- May extend the CSA, therefore increasing income

### ANAEROBIC DIGESTION

- Microorganisms break down biodegradable material
- Area for biogas collection
- Positioned partly below ground; allows heat, a by-product of digestion, to naturally travel up to structures above
- Application of sludge, another by-product of the digester, is a useful fertilizer
- Extra biomass is utilized
- A future, small herd of 9 cattle can generate up to 12 Kw/day



### GREENHOUSE HEATING

- Insulated storage tank for solar hot water
- Radiant floor heating
- Potential fan system with passive coils in submerged air duct

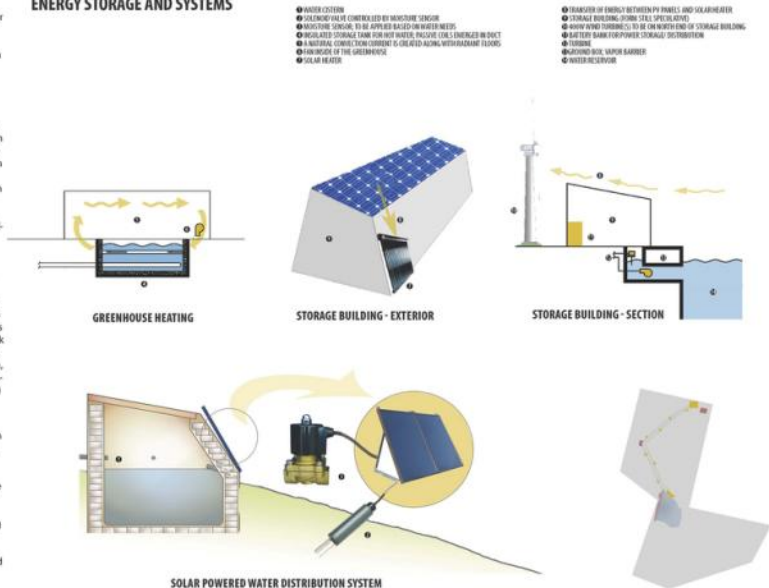
### STORAGE BUILDING

- Exterior to have an array of photovoltaic panels on roof along with solar water heating panels (which could also apply to the radiant heating system in the greenhouse)
- To have a 400w wind turbine (or more depending on need over time) behind the building
- Interior to contain the battery bank for power storage/ distribution
- Micro-hydro turbines to connect the various crop areas to the water pumps between the storage tank and the storage building (located at the top, north, and bottom, near the reservoir, of the current site)

### WATER DISTRIBUTION SYSTEM

- Linked to water irrigation proposal on current site
- Small PV panel are the energy source for the moisture sensors and the solenoid valves
- Ideally, there would be moisture sensors relating to the crop type/ water needs
- Solenoid valve controlled by moisture sensor

## ENERGY STORAGE AND SYSTEMS





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WSU Pierce County Extension  
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Watershed Ecologist

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# Innovation and Evolution of Transportation Systems

- Transportation systems and water quality
- New transportation designs for water quality protection
- WSU Low Impact Development Research Program



# Puget Sound Conditions



- Stormwater a primary driver for decline
- Annual loading of oil  
~22,580 metric tons  
(Exxon Valdez spilled ~33,500 metric tons)
- ~344 metric tons/yr of zinc
- Many pollutants associated with fines (particularly metals), many <0.45 microns (dissolved).

# Low Impact Development Principles and Practices

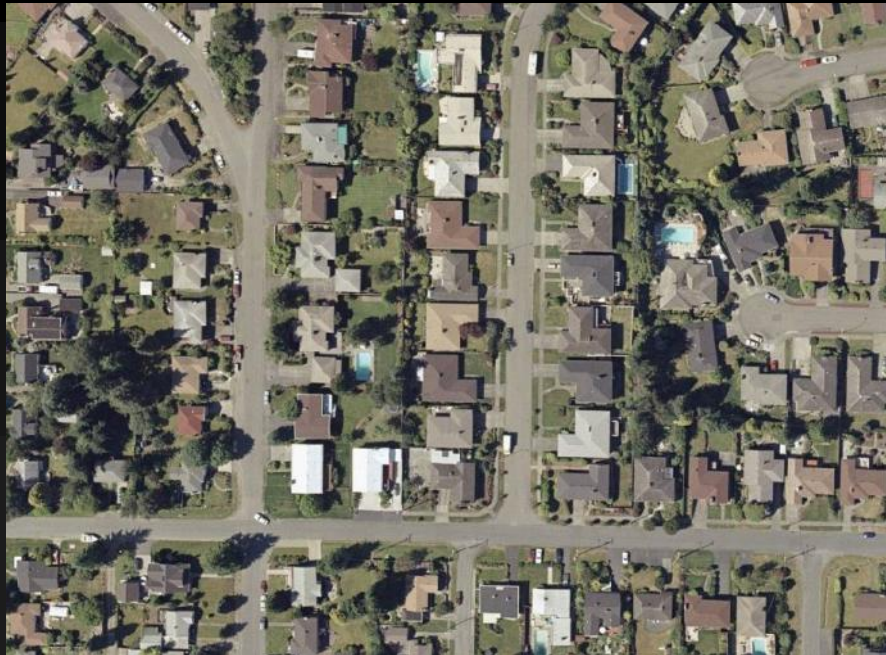


- A land use development strategy that emphasizes protection and use of on-site natural features to manage stormwater.
- Integrated engineered, small scale stormwater controls. WQ treatment integral in all controls.



# The Goal of LID

is to make this...



function more like this











2nd Ave NW, from NW 117th St. to NW 120th St.













FIRSTENBURG BAZAAR  
November 11, 9am-4pm  
487-7001

REGISTER NOW FOR ADULT  
BASKETBALL LEAGUES  
487-7025

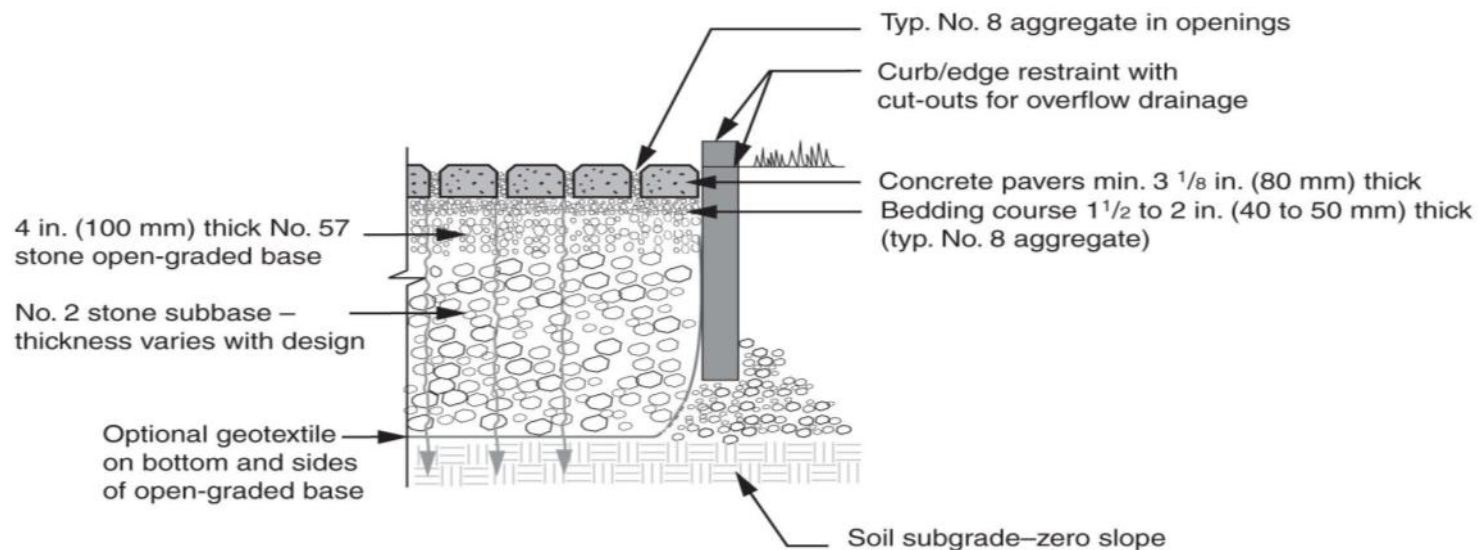




# Permeable Pavers



- Flexible
- Capable of high vehicle loads, used for lower speeds
- High-density concrete that interlock and transfer vertical loads to surrounding pavers





# Road Layout

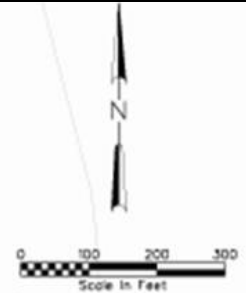
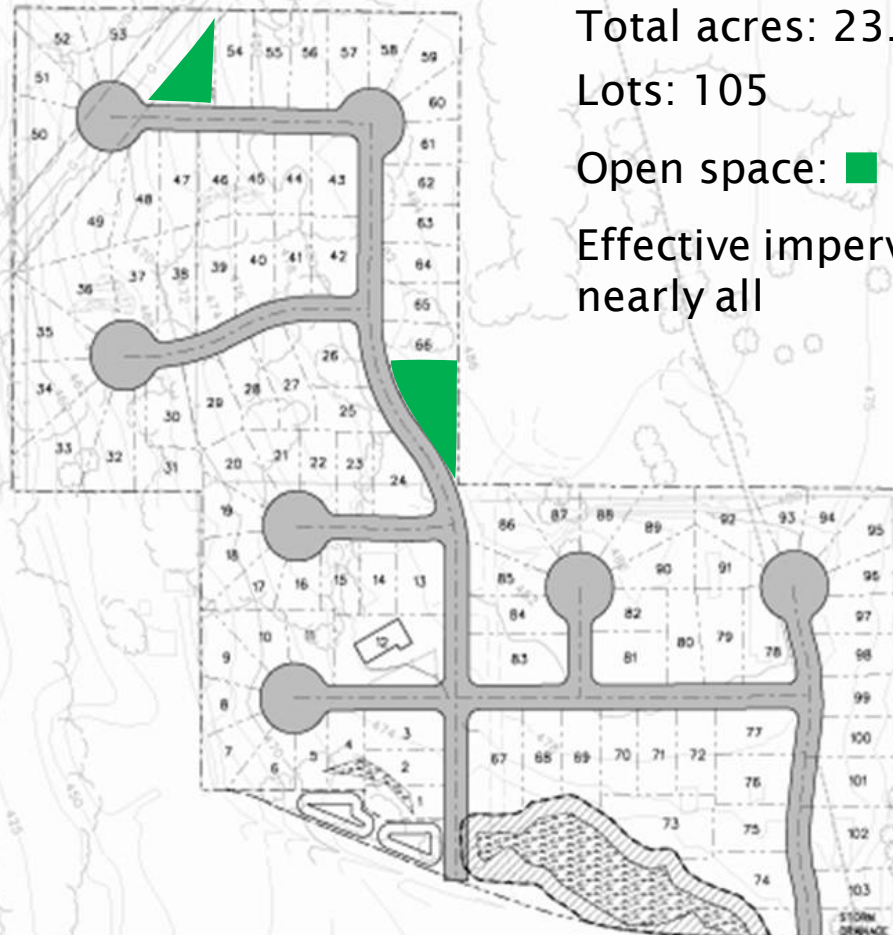
## Kensington Estates

Total acres: 23.92

Lots: 105

Open space: ■

Effective impervious area:  
nearly all







## Kensington Estates

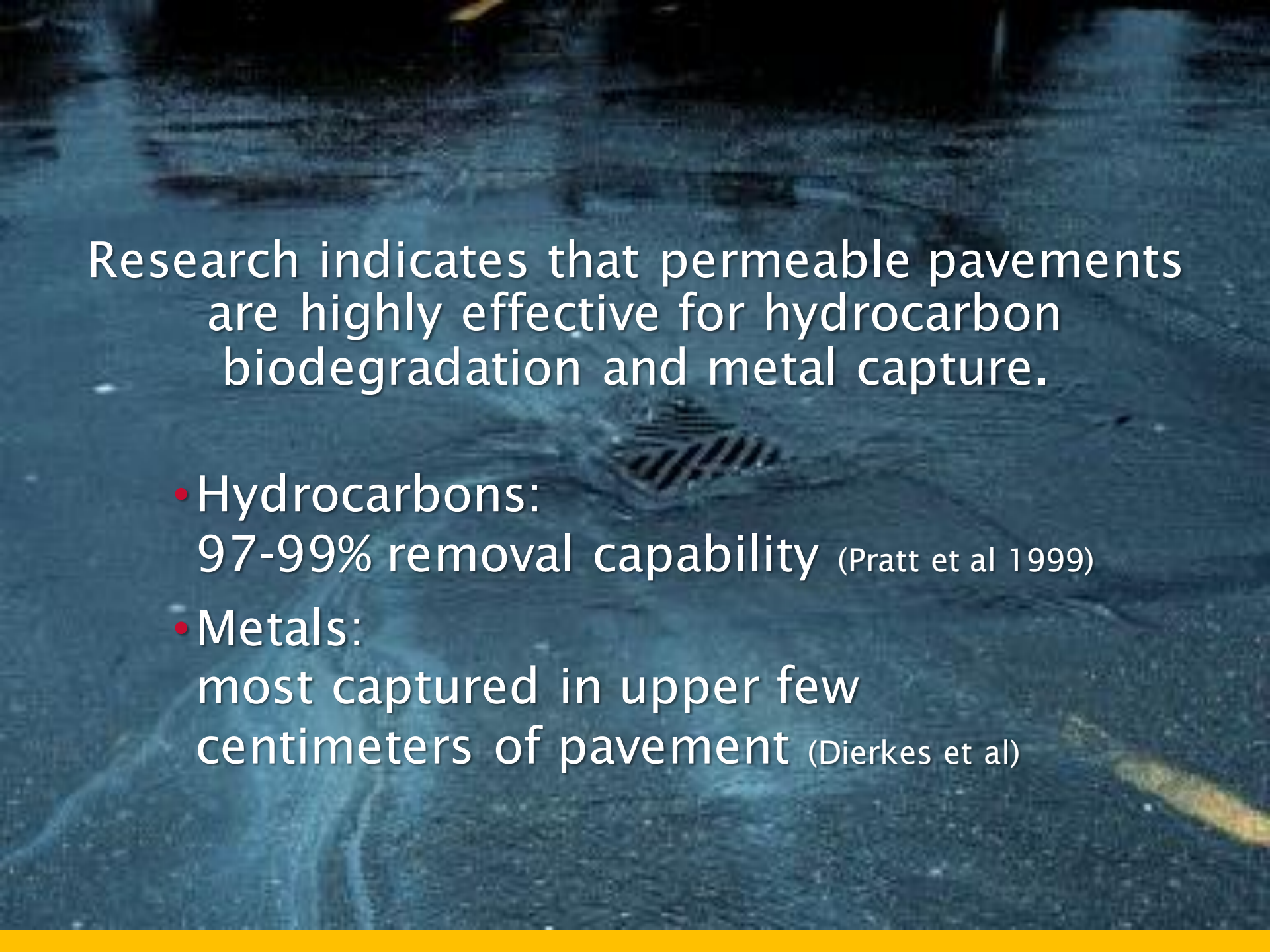
Total acres: 23.92

Lots: 103 (4,143 sq ft Ave.)

Open space: 15 acres (63%)

Effective impervious area:  
approaching 0%





Research indicates that permeable pavements are highly effective for hydrocarbon biodegradation and metal capture.

- Hydrocarbons:  
97-99% removal capability (Pratt et al 1999)
- Metals:  
most captured in upper few centimeters of pavement (Dierkes et al)





### Stratford Place, Sultan

- 20 home residential subdivision
- 32,000ft<sup>2</sup> of pervious concrete
- Eliminated essentially all conventional stormwater practices
- Gained 2 building lots
- Gained \$260,000 in stormwater infrastructure savings and extra lots



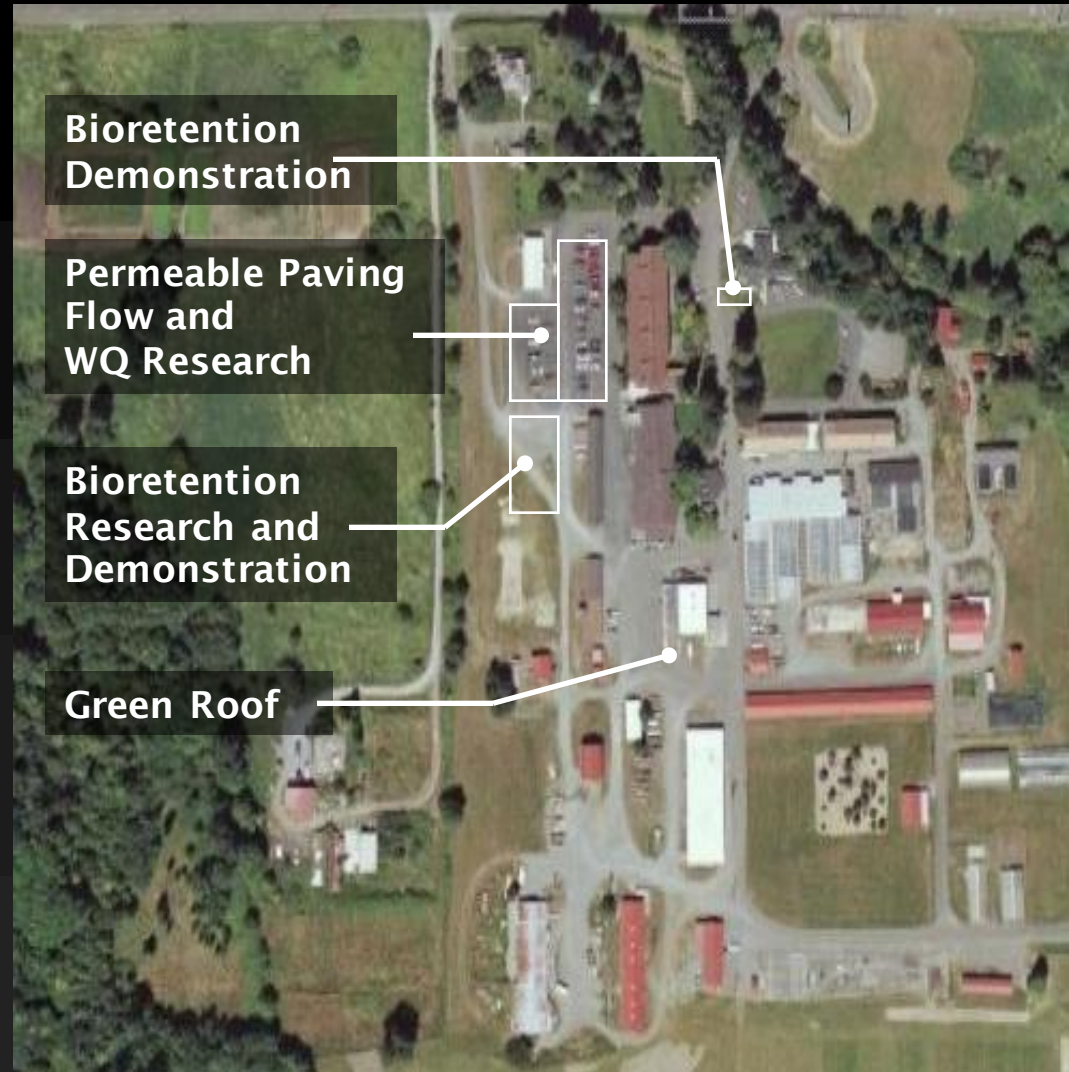
### Marysville Park and Ride

- Ecostone pavers
- 18" sandy peat mix for treatment
- Eliminated essentially all conventional stormwater practices
- Saved ~\$300,000 (total project budget ~\$2 million)



# WSU Puyallup LID Research Program

- A center for LID research and education in Puget Sound and the west
- Pilot scale and replicated research
- Research will integrate civil engineering, soil science, plant science, aquatic toxicology, etc.
- Excellent graduate research and publishing opportunities



# WSU Puyallup LID Research Program

Pervious concrete



Porous asphalt

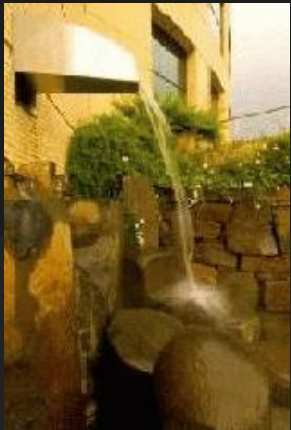
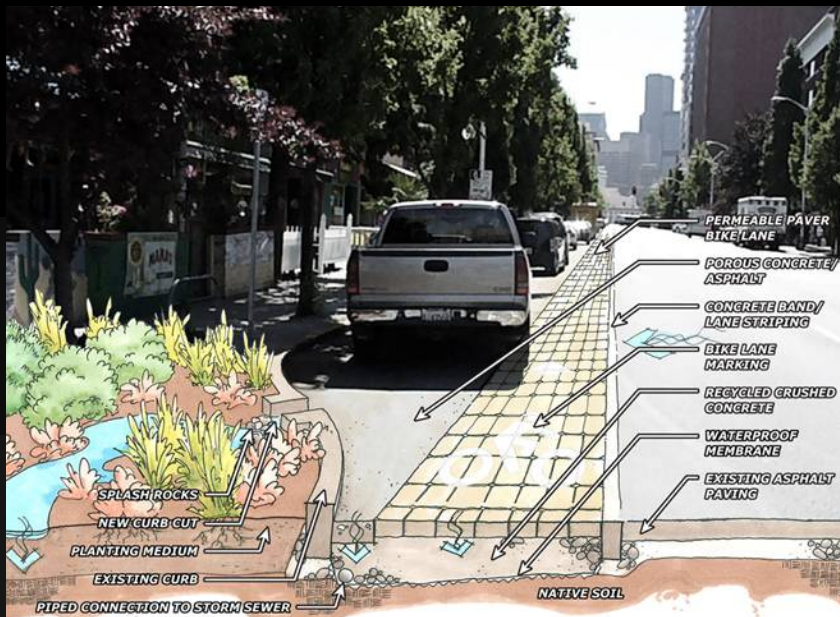


Bioretention

Developing and testing LID systems for enhanced flow control and water quality treatment performance.



# Hydrology Redefining the Urban Landscape



GSI to protect receiving water will significantly change the built environment aesthetic and influence other social and environmental issues.





# Re-tooling Our Education Programs



Innovation will require engineering programs that deliver interdisciplinary civil hydrology/ecology degrees  
...and us.





# Integrating Nature Back into the Built Environment



Europe leading in GSI, but...

The word "INNOVATORS" is rendered in a stylized, uppercase font. The letters are primarily grey, with several letters featuring unique color accents: the first 'N' has a red diagonal slash, the second 'N' has a red diagonal slash, the first 'O' has a green plus sign, the 'V' has a red triangle, the second 'O' has a green plus sign, and the 'R' has a red diagonal slash. The word is flanked by large, green square brackets.

INNOVATORS

inspiring + exploring + transforming





*World Class. Face to Face.*