The Hidden Health Costs of Community Design

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An Old English Quatrain

"The Law Locks Up Both Man and Woman that Steels the Goose from Off the Common …

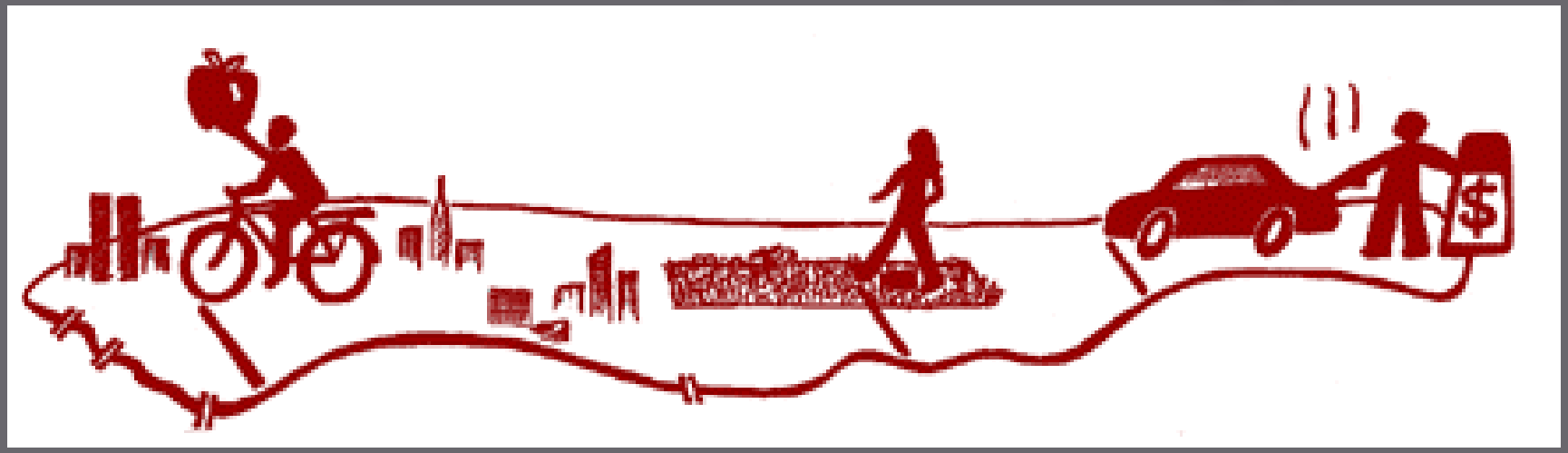
But Lets the Greater Felon Loose,

That Steals the Common from the Goose"

---

a.k.a. The tragedy of the commons

It's All About Energy

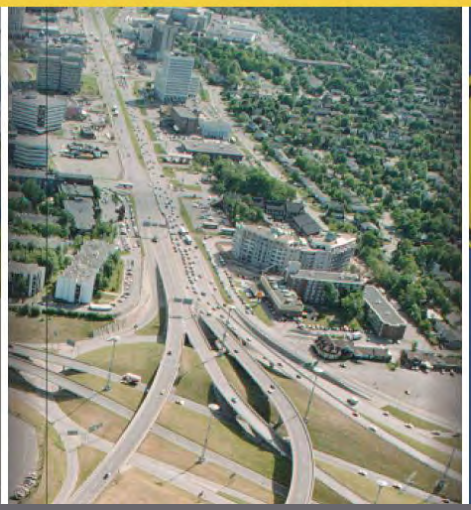


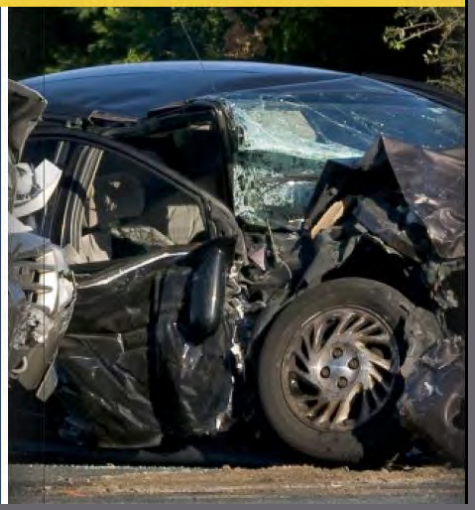
On 350 calories — one apple tart or a "special" slice of Ray's Pizza — a cyclist can travel 10 miles, a pedestrian 3.5 miles, and an automobile 100 feet.

Transportation Alternatives, Bicycle Blueprint, 1998

"Carbonless Footprints" Paper in <u>Preventive Medicine</u>
TRANSPORTATION ENERGY INDEX

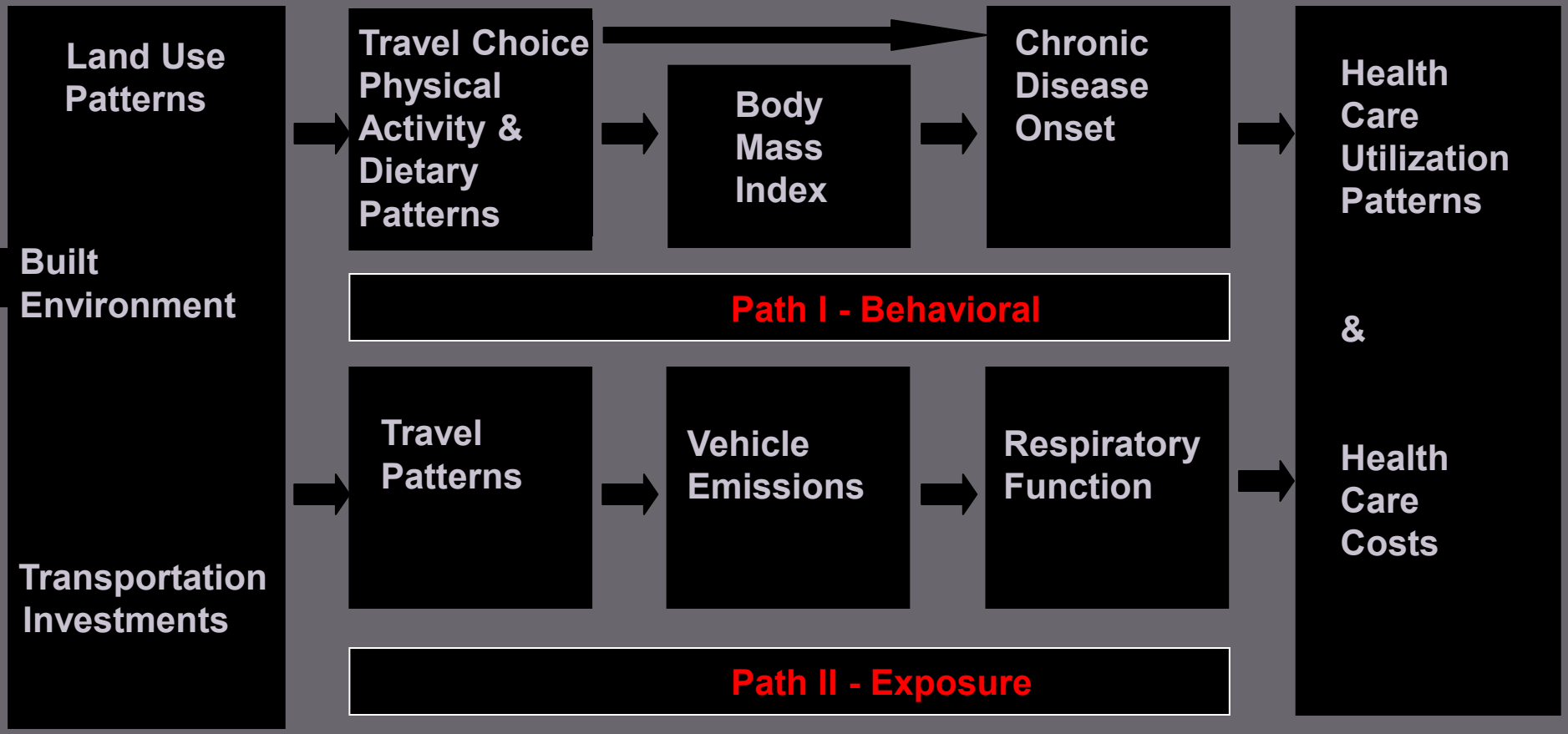
The Hidden Health Costs of Transportation





Kavage, Frank, and Kolian 2010
American Public Health Association

CONCEPTUAL MODEL



Note: **Diet and nutrition**, age, gender, income, genetics, and other factors also impact weight and chronic disease and to the extent possible are controlled in analyses. Vehicle age and climate impacts emissions and air quality, and respiratory function is also impacted by a variety of factors

Dr. Lawrence Frank

Quality of Life
Environmental Quality
Air Quality and Greenspace
Human Behavior
Travel Patterns and Physical Activity
Built Environment
Transportation Investments and Land Use

BASIS FOR STUDY

1) Evidence is clear that built environments likely play a major role in shaping health outcomes and disparities

a) behaviors and b) exposures

2) Recent evidence further clarifies that environments Relate with health outcomes independent of preferences and further suggests the relationship is causal

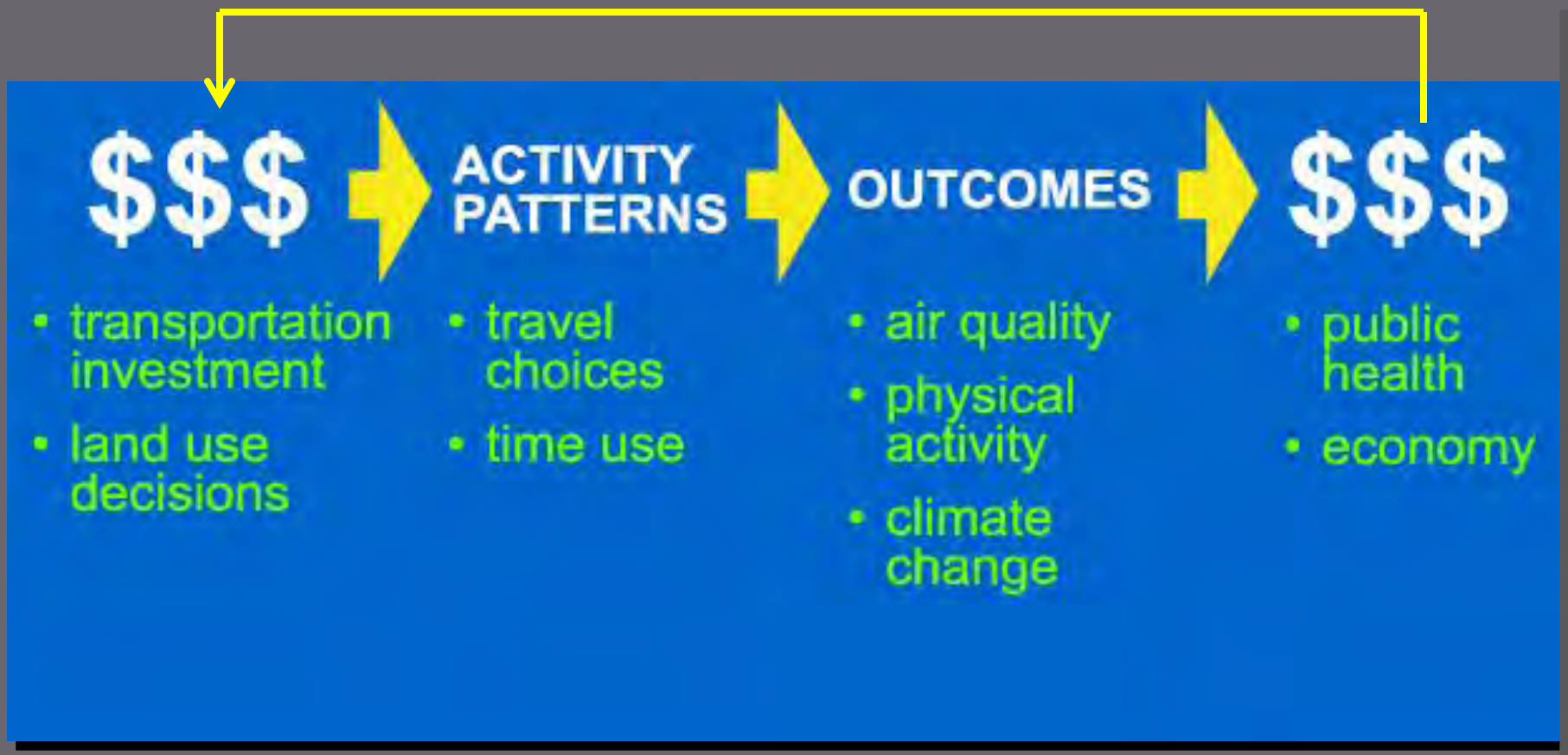
3) Increased odds of meeting physical activity guidelines and reduce risk of obesity are associated with transit use and more walkable environments

a) reduces odds of chronic disease onset for several morbidities

b) logically reduces demands on health care system and associated costs

4) It is both *possible* and *timely* to monetize these costs

The Externalities

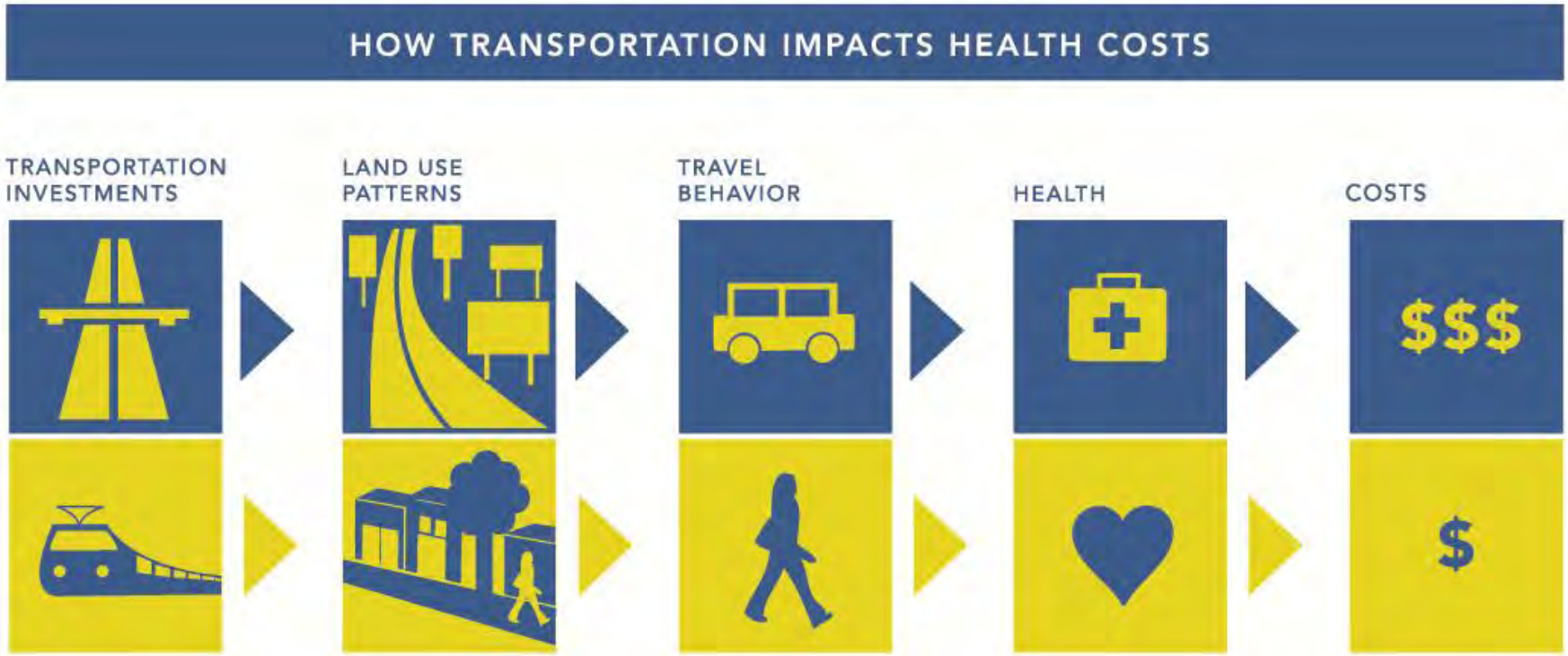


2008 Estimated Costs of Transportation Related health Outcomes (USA)

The National Health Costs of…	$$ (Billions)	Estimate Includes	Source
Obesity and Overweight	$ 142	• Healthcare costs • lost wages due to illness & disability • future earnings lost by premature death	National Institutes of Health, National Institute of Diabetes, Digestive and Kidney Diseases. Statistics Related to Overweight and Obesity: The Economic Costs. Available at: http://win.niddk.nih.gov/statistics/index.htm.
Air Pollution from traffic	$ 50-80	• Healthcare costs • Premature death	Federal Highway Administration. 2000. Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Available at: www.fhwa.dot.gov/policy/hcas/addendum.htm
Traffic Crashes	$ 180	• Healthcare costs • Lost wages • Property damage • Travel delay • Legal / administrative costs • Pain & suffering • Lost quality of life	AAA. Crashes versus Congestion Report. What's the Cost to Society? Cambridge, MD: Cambridge Systematics, Inc.; 2008. www.aaanewsroom.net/assets/files/20083591910.crashesVscongestionfullreport2.28.08.pdf.

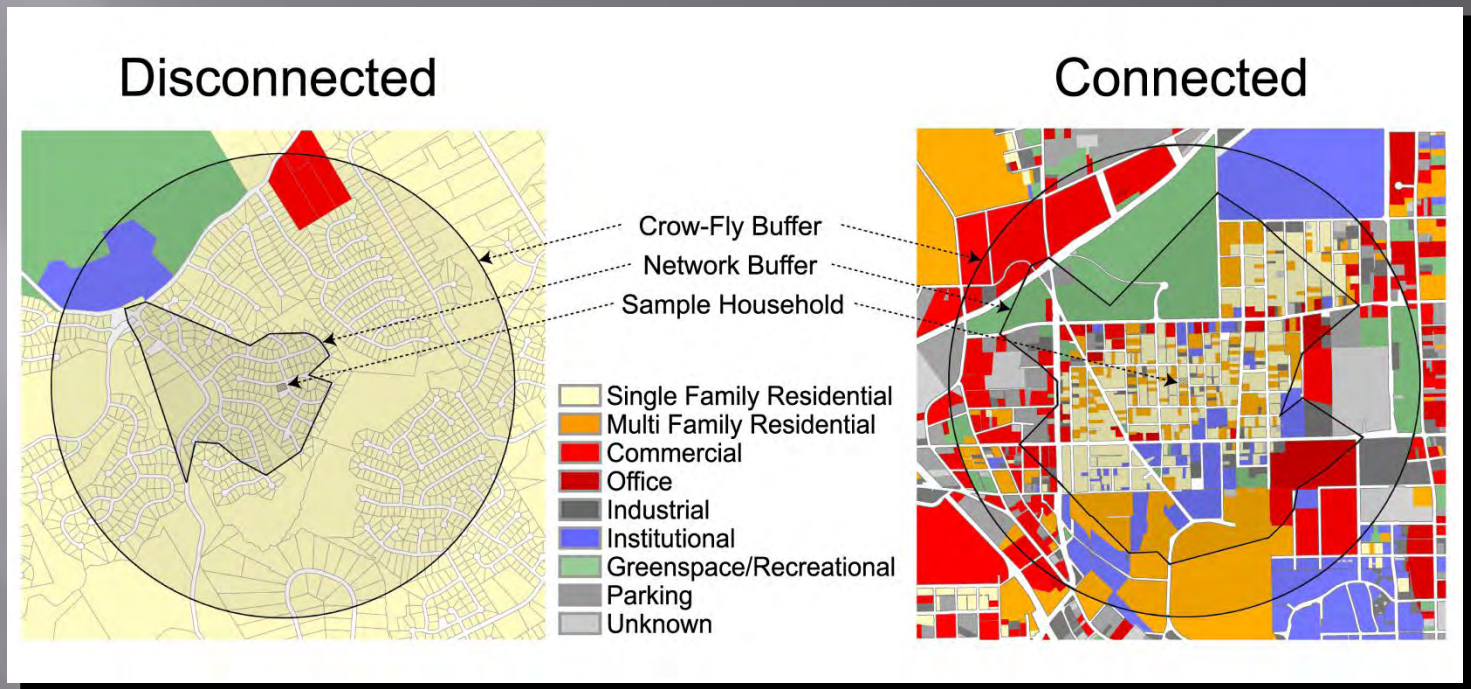
Proposed Approach

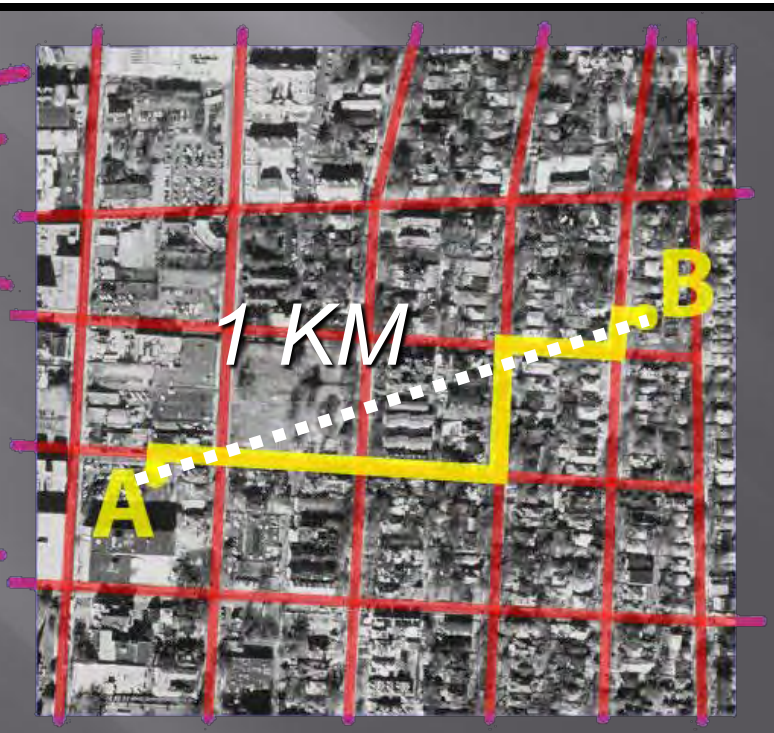
- Summarize the evidence
  - evidence on each link of the behavioral and exposure based causal pathway
- Document methods used to prioritize transportation and land use decisions
  - Cost benefit tools and their lack of accounting for health costs (see:
    - http://www.apha.org/NR/rdonlyres/F84640FD-13CF-47EA-8267-E767A1099239/0/HiddenHealthCostsofTransportationShortFinal.pdf
- Propose to spatially link built environment data with Health outcome Data and with Health Care Utilizitation Records Where Available
  - Using NIH funded databases (www.nqls.org)



“The Hidden Health Costs of Transportation” - Frank et al 2010
American Public Health Association

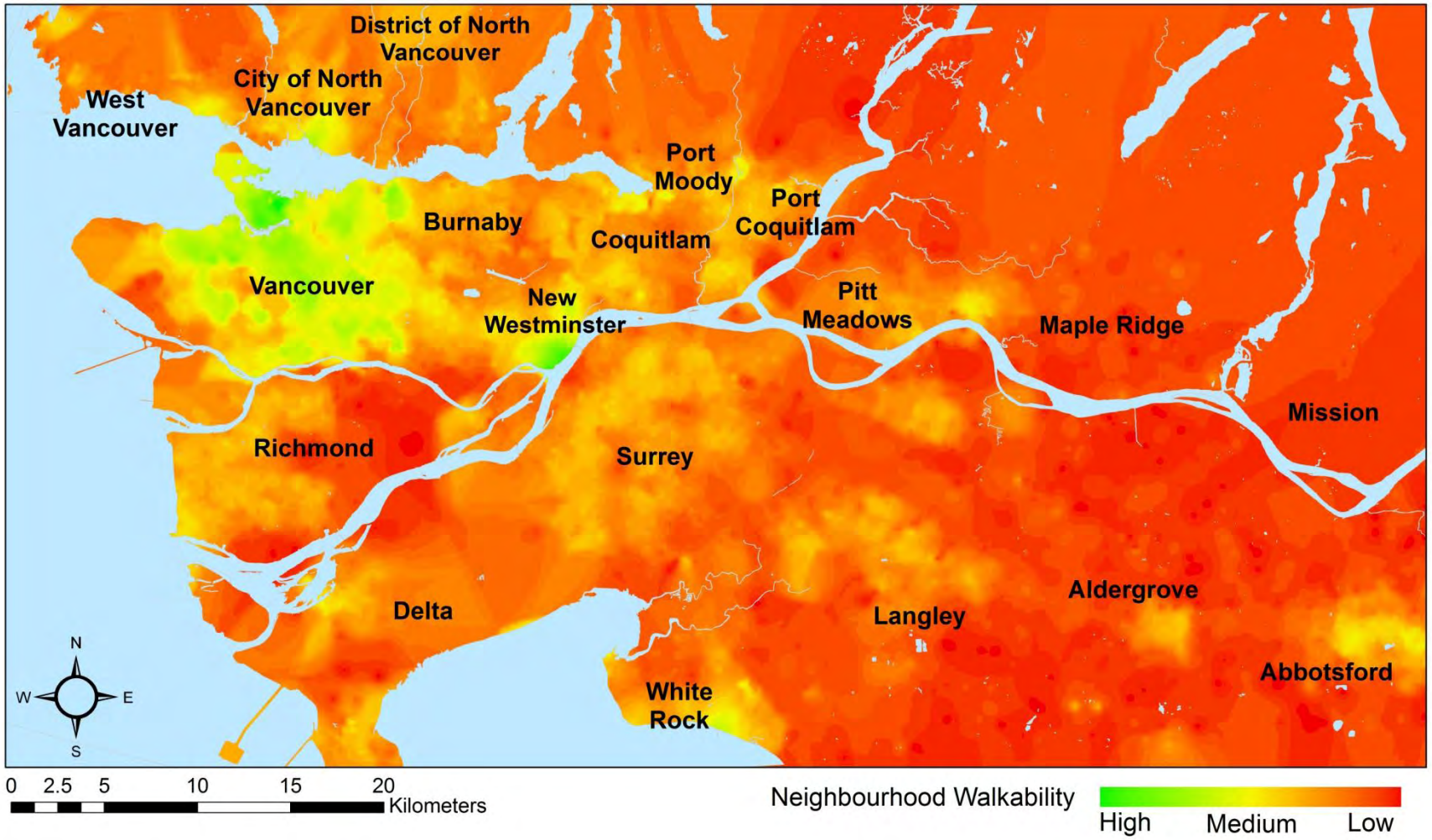
Proximity



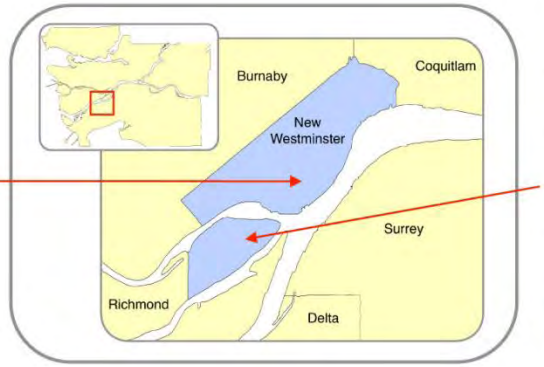


Connect-ivity

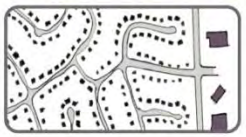
Lower Mainland Walkability Map



Comparing Two Communities



	Uptown Moody Park	Queensborough
Net Residential Density (dwelling units/acre)	40.29	7.73
Mixed Use Index (range 0 – 1)	0.58	0.09
Intersection Density (per square km)	70.12	27.91
Retail Floor Area Ratio	0.64	0.30
Overall Walkability	4.26	-3.74



Adult Findings – Transit Use

Built environment characteristics explaining transit use in adults

	Any transit trip	Work/school transit trip	Non-work/school transit trip
Higher residential density	++	+	+
Higher street connectivity	++	+	++
Higher commercial density	+++	NS	+
Higher mix of land uses	++	++	NS
More nearby parks and open spaces	NS	NS	NS
Higher overall neighbourhood walkability	++	++	++

NS = not significant, '+' = 95% significant; '++' = 99% significant, '+++' = 99.9% significant

Devlin and Frank, 2009

Adult Findings – Walking

Built environment characteristics explaining walking in adults

	Any walk trip	Work/school walk trip	Non-work/school walk trip
Higher residential density	+++	+++	+++
Higher street connectivity	+++	+++	+++
Higher commercial density	+++	+++	+++
Higher mix of land uses	++	+	++
More nearby parks and open spaces	+++	+	+++
Higher overall neighbourhood walkability	+++	++	+++

NS = not significant, '+' = 95% significant; '++' = 99% significant, '+++' = 99.9% significant

Devlin and Frank, 2009

Transit Use and Physical Activity

- Transit use was significantly associated with greater odds of meeting physical activity recommendations (OR=3.42; CI=2.40-4.87)
  - by walking for transportation
- The odds of meeting 30 minute Physical Activity Recommendation is negative for additional trips as a car driver when compared to moderate walking (OR =.87; CI=0.76-0.99)

Source: LaChapelle and Frank, *2009*

Objective physical Activity and Objective Built Environment

- 2005 study found that residents of the most walkable areas in Atlanta were 2.4 times more likely to get the recommended amounts of physical activity
- 18 percent in the lowest Versus 37 Percent in the highest levels of walkability got recommended levels of physical activity

- Frank LD, Schmid TL, Sallis JF, Chapman JE, Saelens BE. 2005. "Linking Objective Physical Activity Data with Objective Measures of Urban Form." American Journal of Preventive Medicine. Volume 28, No. *2 (Suppl2): pp.* 117-125.

Physical Activity Case Study: Estimated Costs Savings from Walkable Urban Design

Land Use/Urban Design Characteristics	Change in Amount of Walking (Miles, over a two-day period)		Number of Persons Who Will Move from First to Second Tertile of Physical Activity		Annual Lives Saved		Present Discounted Value (in Dollars)	
	Low (median–75th percentile)	High (median-95th percentile)	Low	High	Low	High	Low	High
Street connectivity (intersection density)	0.3816	1.1844	22.79	78.59	0.0456	0.1572	$2,255,107	$23,205,007
Retail employment density (retail 0.0652 jobs/square mile	0.0652	0.9734	4.72	62.09	0.0094	0.1242	$466,574	$18,331,955
Total employment density (jobs/ 1.0648 square mile)	0.0019	1.0648	1.57	66.02	0.0031	0.1320	$155,525	$19,492,206
Population density (persons/ square mile)	0.2581	0.549	15.72	28.29	0.0314	0.0566	$1,555,247	$8,353,802
Distance to central business district (miles)	–0.8108	–2.5054	45.58	209.05	0.0912	0.4181	$4,510,215	$61,725,318

Predictors of Obesity

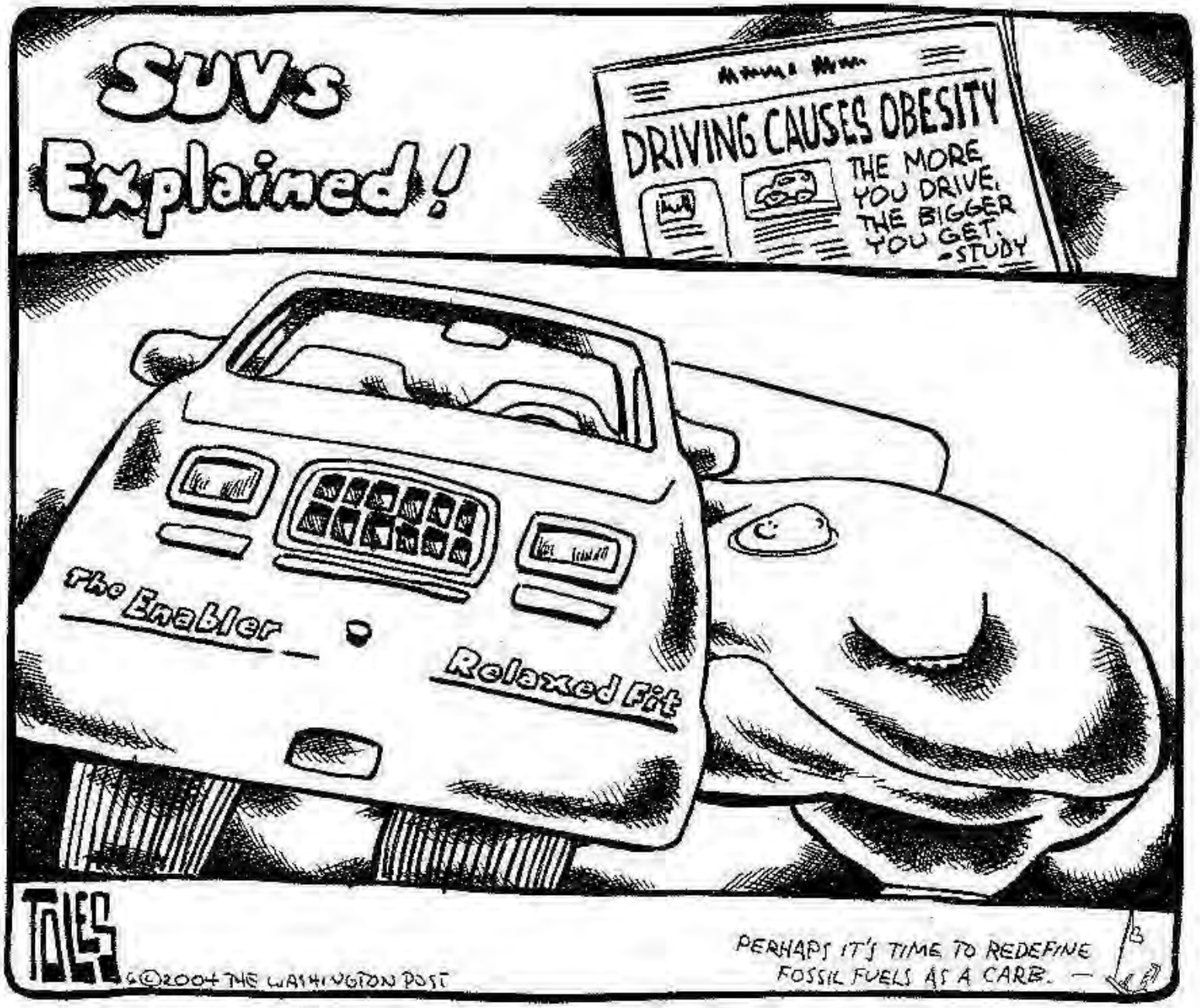
	Coefficient	t-Ratio	P-Value
↑ **Age**	0.012	6.00	0.000
↓ **Education**	-0.080	-4.71	0.000
↓ **Income**	-0.057	-4.75	0.000
↓ **Walk Distance**	-0.049	-2.04	0.034
↑ **Car Time**	0.001	2.875	0.003
↓ **Land Use Mix**	-2.035	- 5.65	0.000
↑ **Black Male**	0.311	3.930	0.000
↑ **Black Female**	0.372	5.09	0.000
↓ **White Female**	-0.871	-11.3	0.000
Constant	-0.497	-2.22	0.026

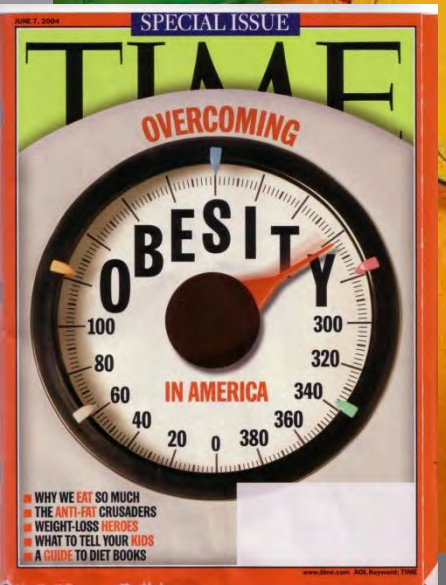
Frank, L., Andresen, M., and Schmid, T., Obesity Relationships With Community Design, Physical Activity, and Time Spent in Cars. American Journal of Preventive Medicine. June 2004.

Obesity Results – Driving and Walking

- Every additional hour per day in a car translates into a 6 percent increase in the likelihood of obesity
  - Time spent driving increases as walkability decreases
- Every additional Kilometer (.6 miles) walked translates into 4.8 percent reduction in the likelihood of being obese
  - Distances walked increases with walkability

Frank, L., Andresen, M., and Schmid, T., Obesity Relationships With Community Design, Physical Activity, and Time Spent in Cars. American Journal of Preventive Medicine. June 2004.


SUVs Explained!
DRIVING CAUSES OBESITY
THE MORE YOU DRIVE, THE BIGGER YOU GET. -STUDY
The Enabler
Relaxed Fit
TOLES
©2004 THE WASHINGTON POST
PERHAPS IT'S TIME TO REDEFINE FOSSIL FUELS AS A CARB. —


JUNE 7, 2004
SPECIAL ISSUE
TIME
OVERCOMING
OBESITY
IN AMERICA
0
20
40
60
80
100
0
380
360
340
320
300
WHY WE EAT SO MUCH
THE ANTI-FAT CRUSADERS
WEIGHT-LOSS HEROES
WHAT TO TELL YOUR KIDS
A GUIDE TO DIET BOOKS

LOGISTIC REGRESSION ANALYSES PREDICTING THE ODDS OF WALKING AT LEAST ONCE OVER 2-DAYS

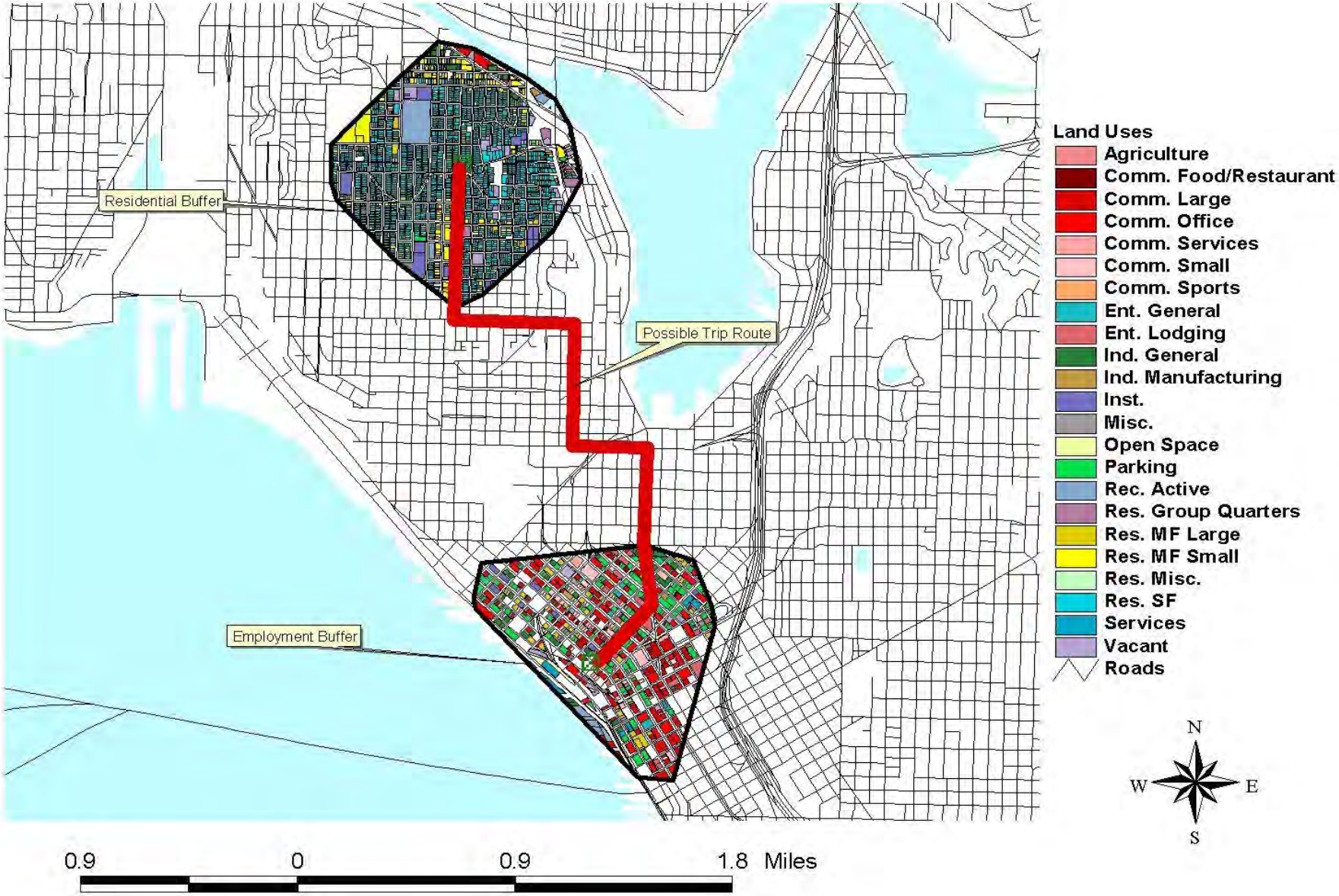
YOUTH Age Range	5-8 years OR (95% CI)	9-11 years OR (95% CI)	12-15 years OR (95% CI)	16-20 years OR (95% CI)
	N=847	N=632	N=867	N=815
Intersection highest tertile (vs lowest)	1.7 (1.0-2.9)	1.3 (0.8-2.3)	1.7 (1.1-2.8)*	2.0 (1.1-3.6)*
Density highest tertile (vs lowest)	1.8 (1.0-3.1)	2.3 (1.2-4.3)**	3.7 (2.2-6.4)***	2.0 (1.0-4.1)
Mixed land use (vs no mix)	1.5 (0.9-2.4)	1.5 (0.9-2.5)	2.5 (1.6-3.8)***	1.9 (1.0-3.2)*
At least 1 commercial land use (vs 0)	1.5 (0.9-2.4)	1.6 (1.0-2.5)	2.6 (1.7-4.0)***	1.7 (1.0-3.1)
At least 1 recreation/open space land use (vs 0)	**2.1** (1.3-3.4)***	1.8 (1.1-2.9)*	2.5 (1.7-3.6)***	1.8 (1.1-2.9)**

controlling for socio-demographics and stratified by age group
(Averaged over a two day period)

*p<.05, **p<.01, ***p<.001

(Youth) Walking and Vehicle Ownership

- Compared with youth from households with 3 or more cars (99.9% confidence level):
  - Youth from households with 2 cars were 1.4 times more likely to walk at least once over a two day period
  - Youth from households with 1 car were 2.6 times more likely to walk at least once over a two period and 2.2 times more likely to walk more than a ½ mile per day
  - Youth from households with no cars were 7.7 times more likely to walk at least once a two day period and 6.8 times more likely to walk more than a ½ mile per day.


Residential Buffer
Possible Trip Route
Employment Buffer
Land Uses
Agriculture
Comm. Food/Restaurant
Comm. Large
Comm. Office
Comm. Services
Comm. Small
Comm. Sports
Ent. General
Ent. Lodging
Ind. General
Ind. Manufacturing
Inst.
Misc.
Open Space
Parking
Rec. Active
Res. Group Quarters
Res. MF Large
Res. MF Small
Res. Misc.
Res. SF
Services
Vacant
Roads
N
W
E
S
0.9
0
0.9
1.8 Miles

Methodology to Estimate Household Emissions

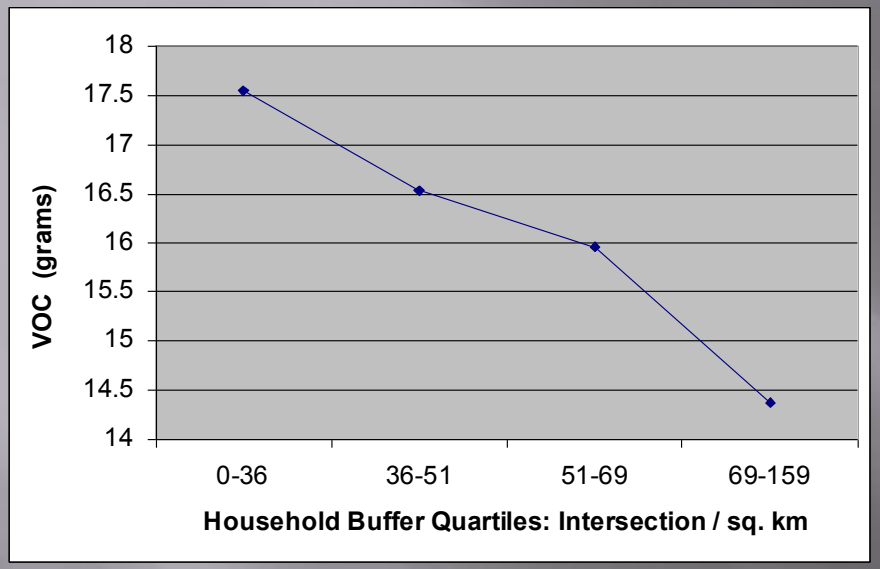
Facility Type	Distance	AM Peak Speed	Emission Estimates
	(miles)	(mph)	
Local Road	0.8	20	*Using EPA sanctioned models, gram per mile emissions of HC, CO, NOx, and PM will be calculated.*
Minor Arterial	0.5	25	
Major Arterial	4	35	
Freeway	7.5	55	
Total	**12.8**		

The model speed will be used based on the facility type instead of assuming an average trip speed.

GeoStats and LFC, Inc.

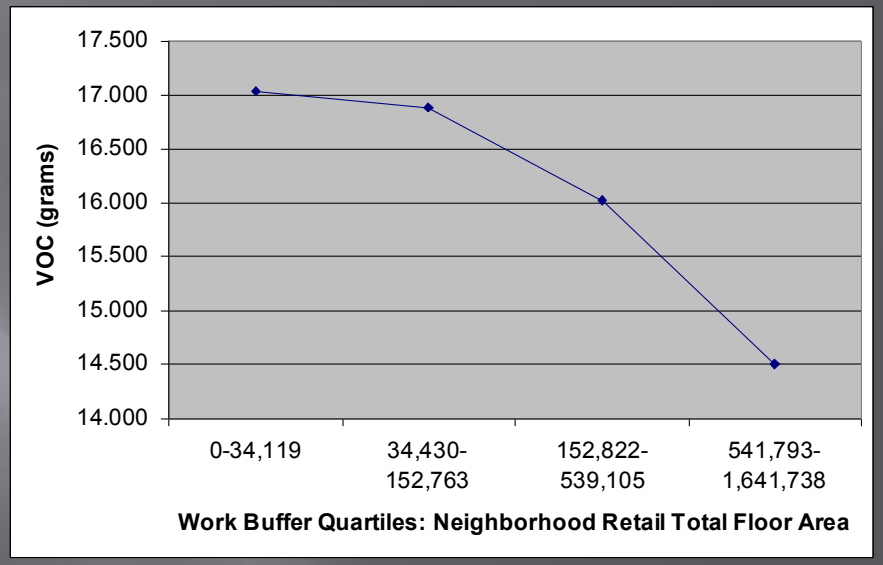
OZONE - AIR POLLUTION

LIVE



Volatile Organic Compounds & Intersection Density Where People Live * (n=2467)

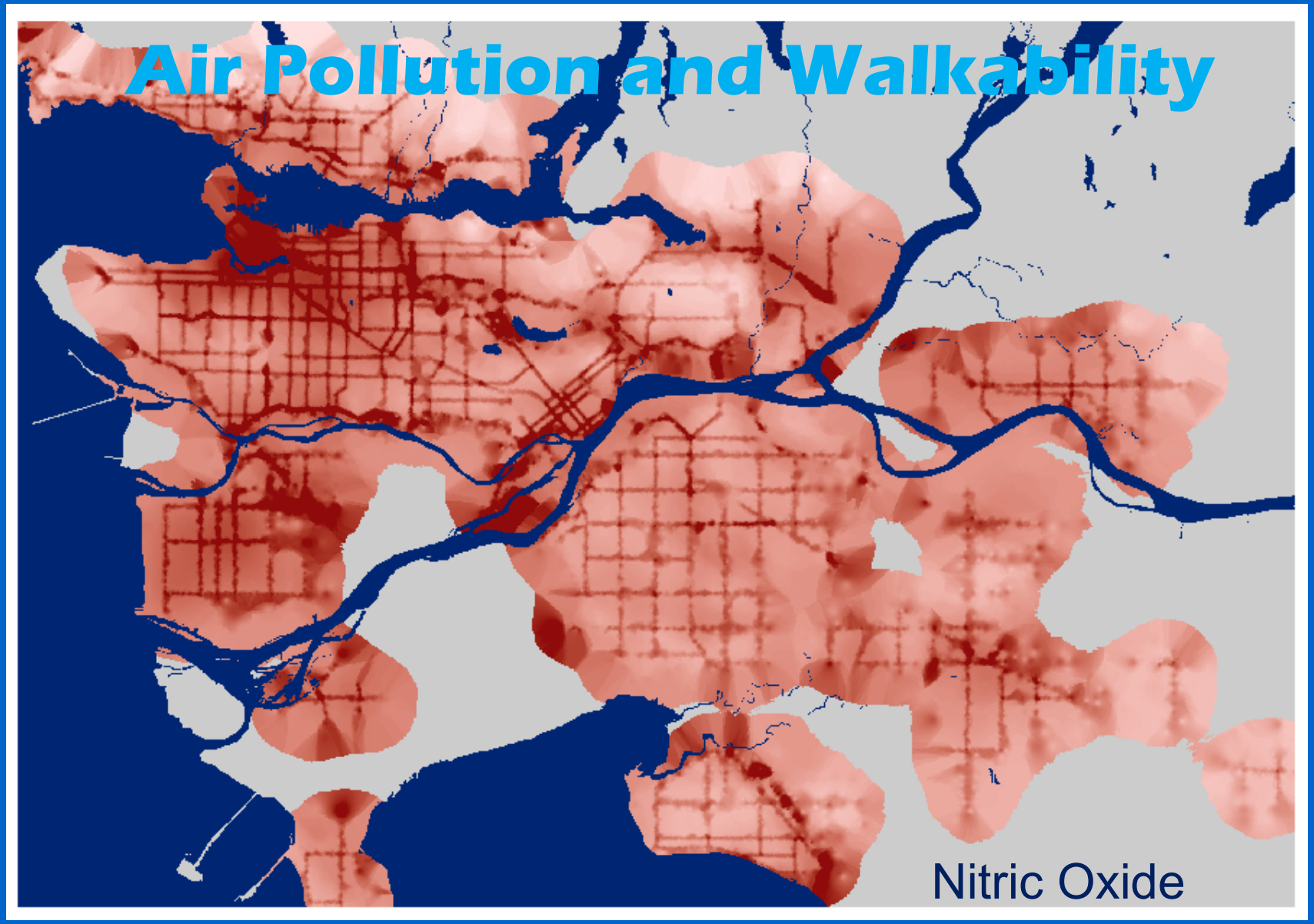
WORK



Volatile Organic Compounds and Retail Use Where People Work * (n=2467)

* Controlled for gender, income, age, total number of vehicles in the house

* VOC differences across quartiles significant ($p<0.001$



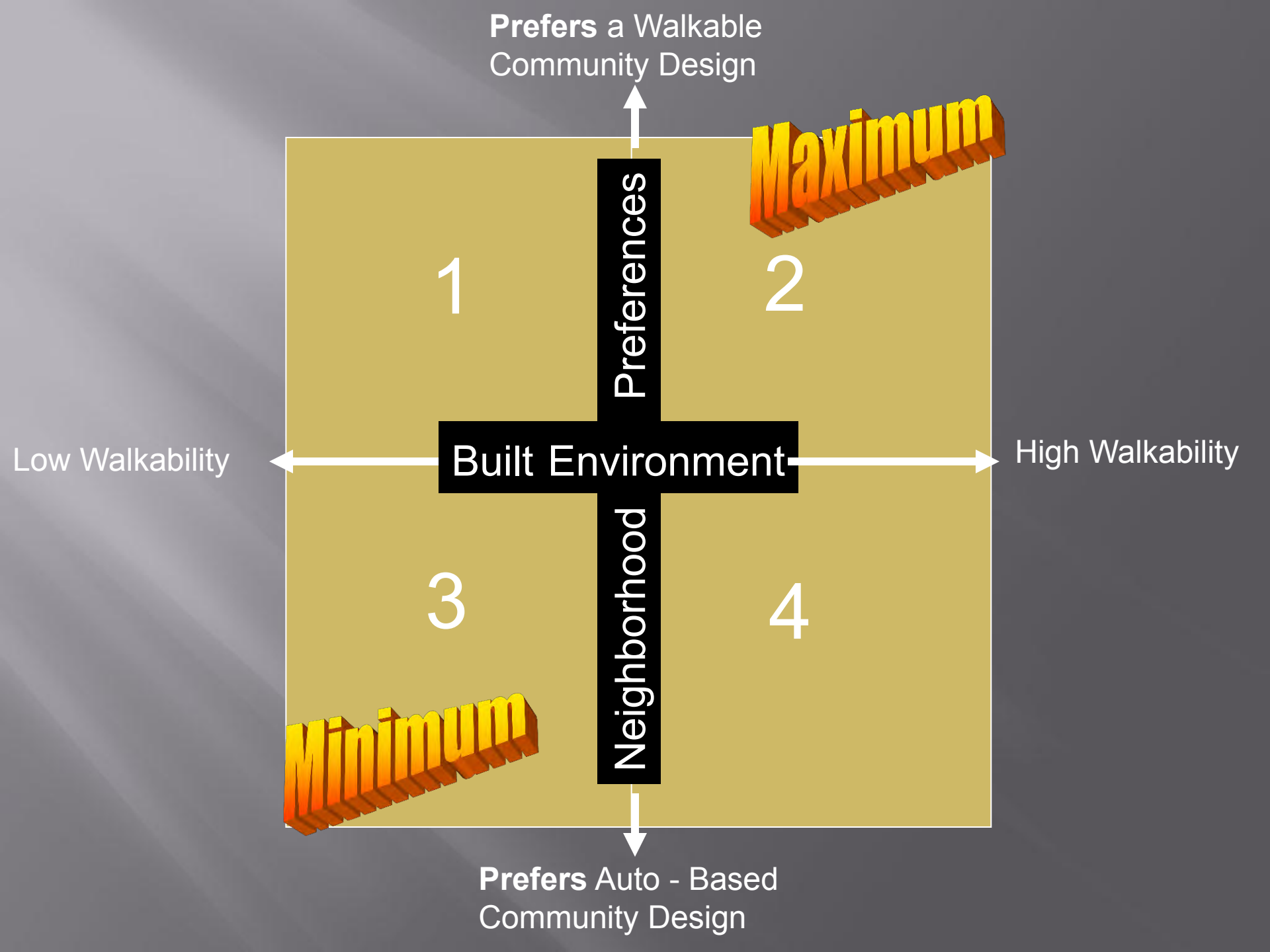
Marshall, Brauer, and Frank 2008

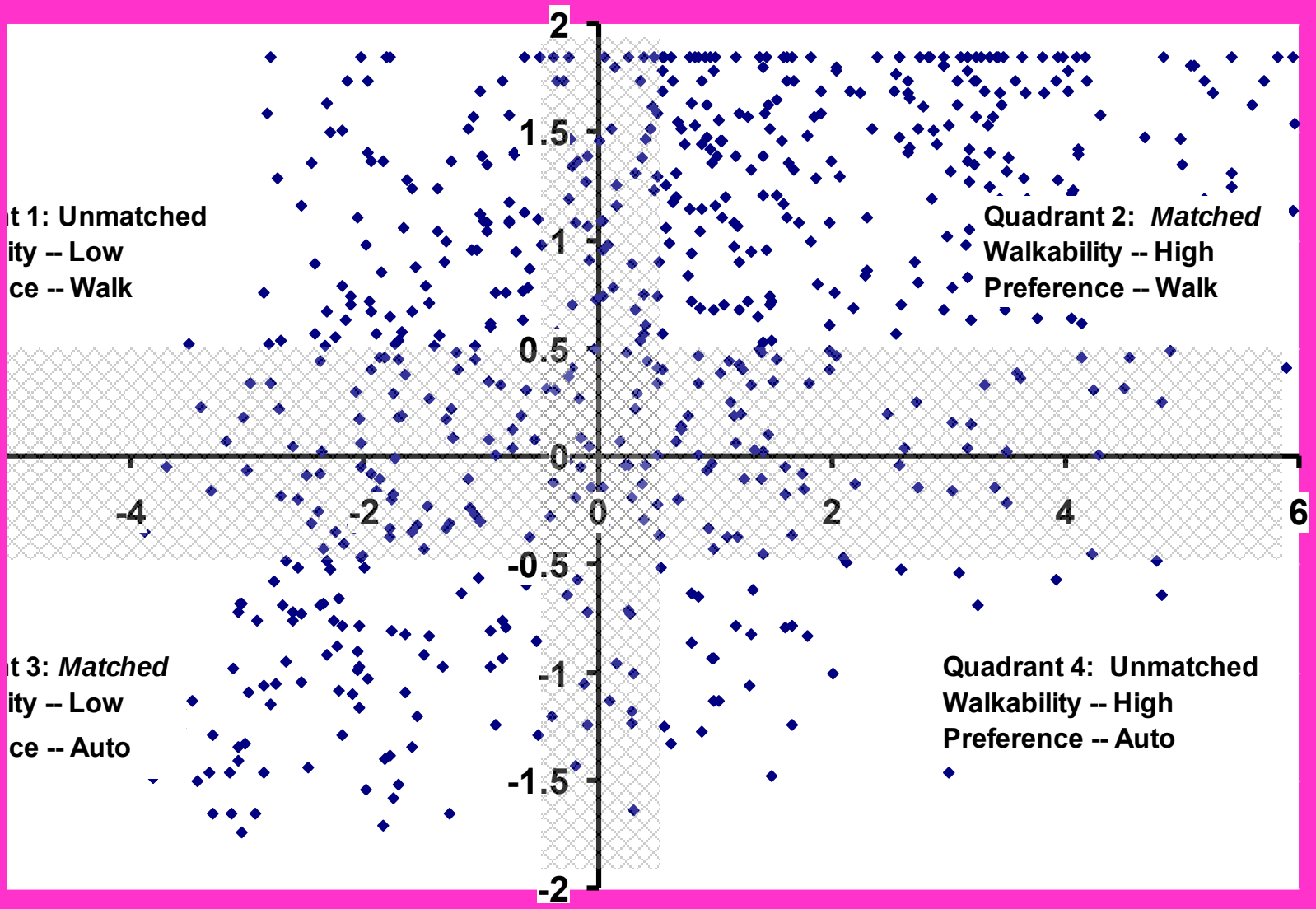
Stepping Towards Causation

Residential Density and Mix of Housing Type

If I were to move, I'd like to find a neighborhood . . .

A. that is a lively and active place, even if this means it has a mixture of single family houses, townhouses, and small apartment buildings that are close together on various sized lots.	*or*	**B.** with single family houses farther apart on lots 1/2 acre or more, even if this means that it is not an especially lively or active place.


Prefers a Walkable Community Design
Maximum
1
2
Preferences
Low Walkability
Built Environment
High Walkability
3
4
Neighborhood
Minimum
Prefers Auto - Based Community Design


2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-4
-2
0
2
4
6
t 1: Unmatched
ity -- Low
ce -- Walk
Quadrant 2: *Matched*
Walkability -- High
Preference -- Walk
t 3: *Matched*
ity -- Low
ce -- Auto
Quadrant 4: Unmatched
Walkability -- High
Preference -- Auto

PREFERENCE VS NEIGHBORHOOD DESIGN

	Walkability & Preference Groups		Percent Taking a Walk Trip (n)	Average Daily Vehicle Miles Traveled (n)	Pe Ol
	Preference for Neighborhood Type	Walkability of Current Neighborhood			
I	**High**	**Low**	16.0% (188)	36.6 (188)	14 (
II	**High**	**High**	33.9% (446)	25.8 (446)	1 (
III	**Low**	**Low**	3.3% (246)	43.0 (246)	2 (
IV	**Low**	**High**	7.0% (43)	25.7 (43)	2 (

FIGURE 12 - Walking, Driving and Obesity by Neighborhood Preferenc

Changing Demographics

- Aging population
  - Smaller communities are attractive for retiring baby boomers
  - Requires recreational amenities and high quality walkable environments to reduce vehicle dependence
- Where will the 65-plus population live?
  - Access to services
  - Less reliance on driving for safety reasons
  - Maintaining Independence
- For elderly, considering cost of service delivery with Aging in Place
  - Suburban Vs Urban setting

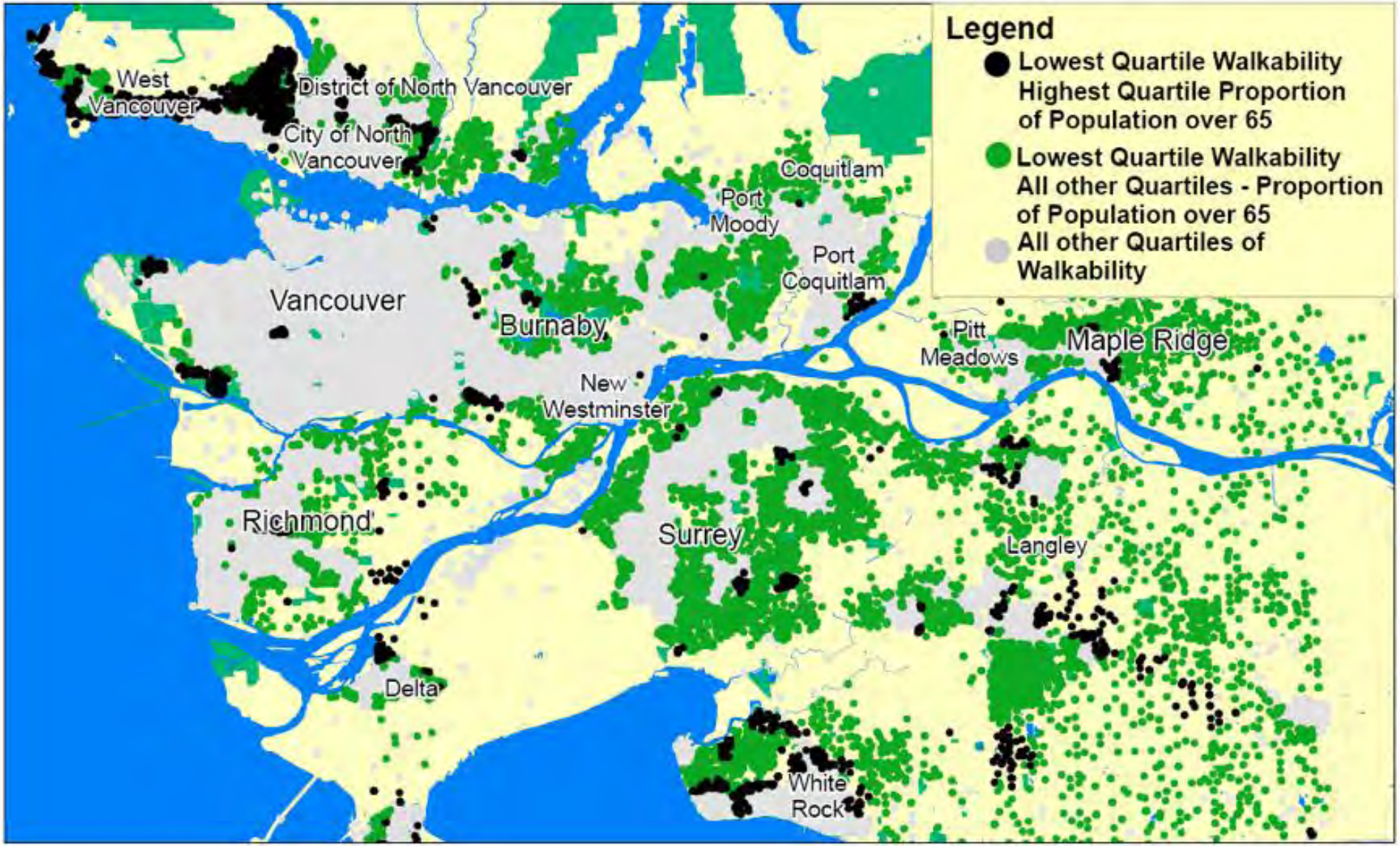
The Silver Tsunami

- "By 2032, 1/4 of B.C. residents will be over age 65."
  - Vancouver Sun September 17, 2011
- California will see its 65-plus population more than double in the next 25 years, from 3.5 million in 2000 (10.6 percent of the state's population) to 8.2 million in 2030 (17.8 percent).
  - Where will the 65-plus population live?
  - Access to services, Less reliance on driving for safety reasons, Maintaining Independence
- Lack of Affordable Housing in Walkable Places
  - Cost of service delivery with Aging in central / walkable versus peripheral / unwalkable places

Healthy Aging Paper – Summary of Findings

- Increased walkability was related with more walking (OR 2.02), less time spent traveling in a car (OR .53), and lower odds of being overweight (OR .68).
- Those with 1 or no cars were more likely to walk (OR 2.9) and spend less time in cars (OR .53); but also less likely to get recommended levels of PA (OR .55).
- Visiting a fast food outlet was associated with increased odds of obesity (OR 1.81).

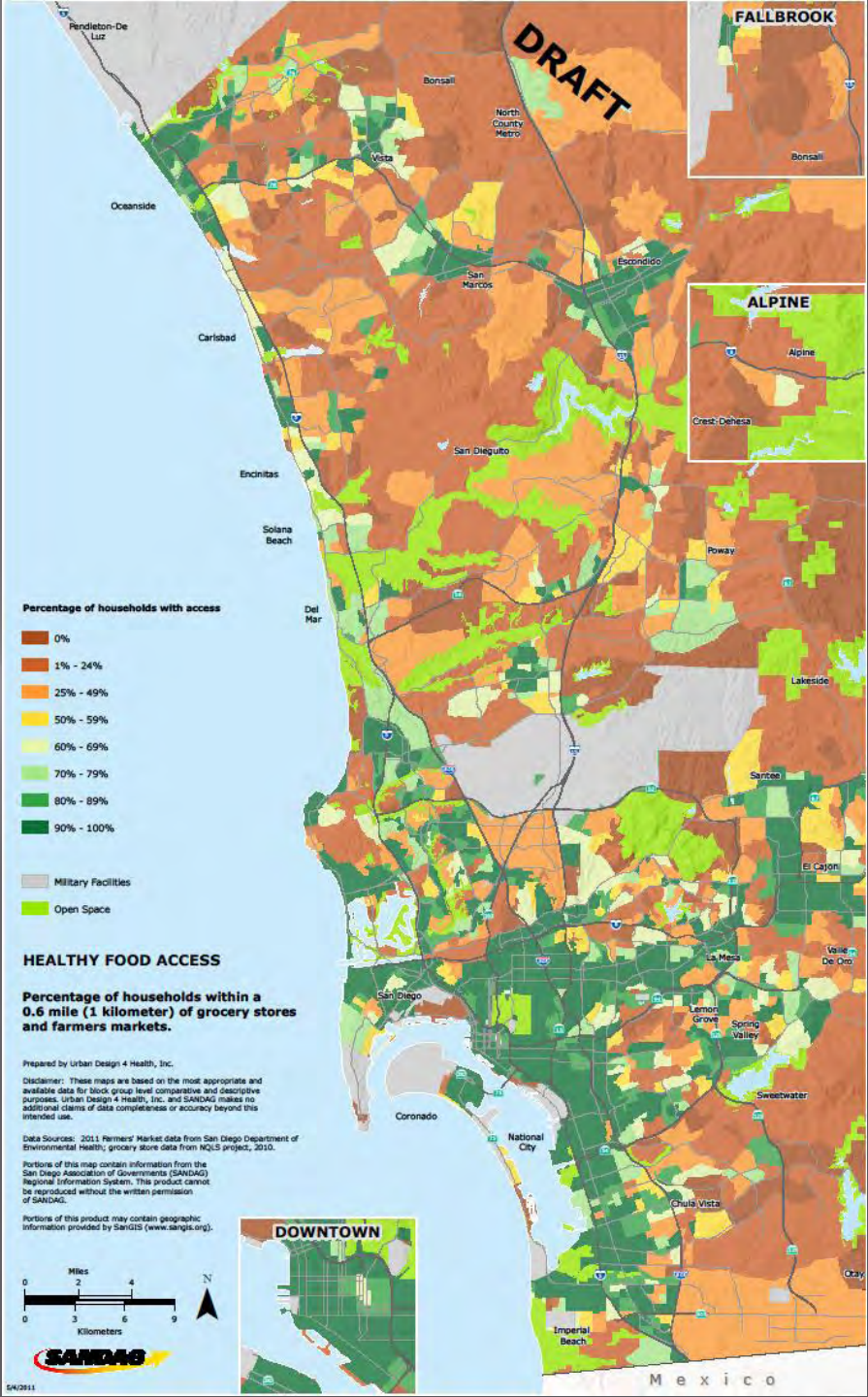
Walkability and Elderly

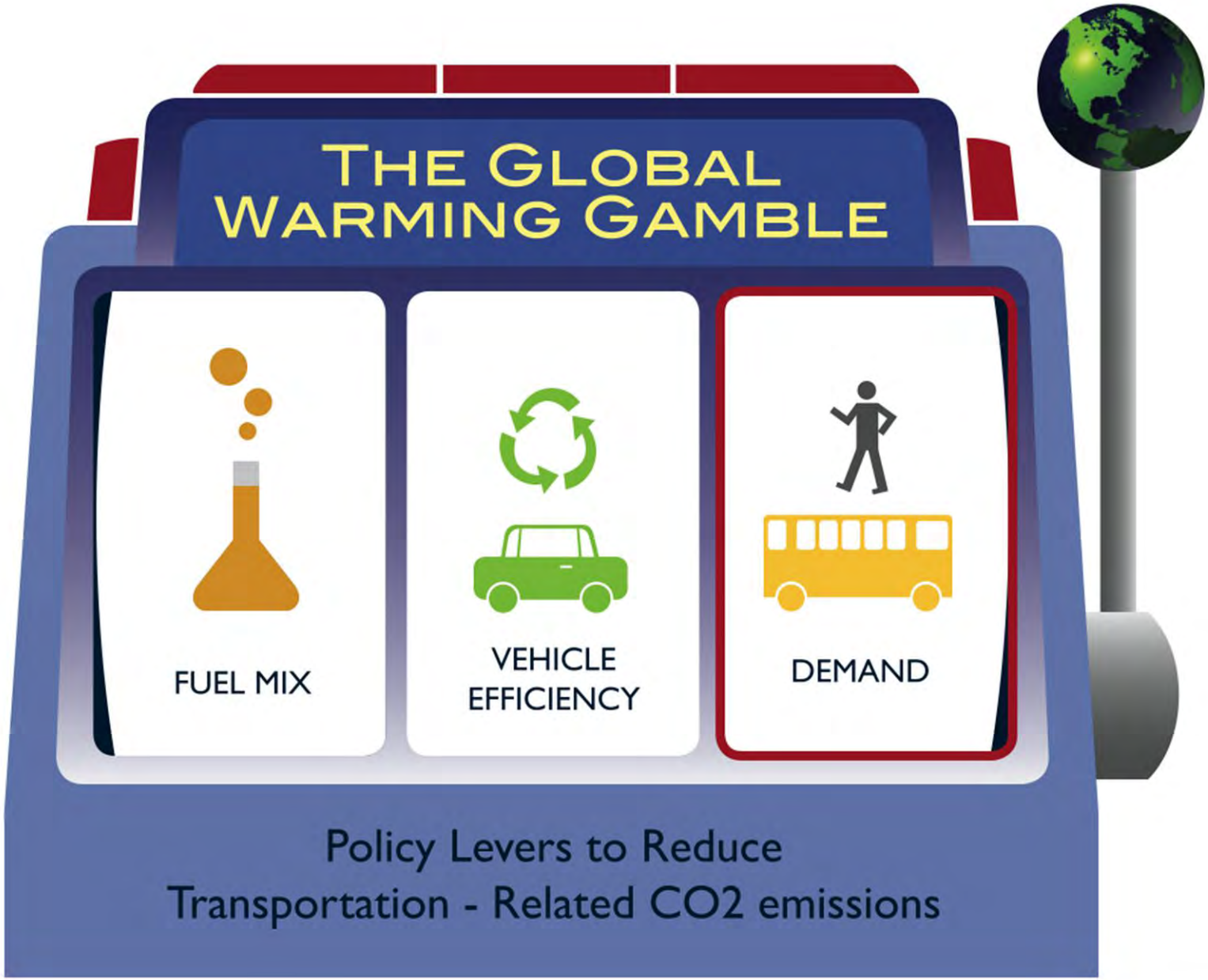


Food Environments Impact Obesity as Well

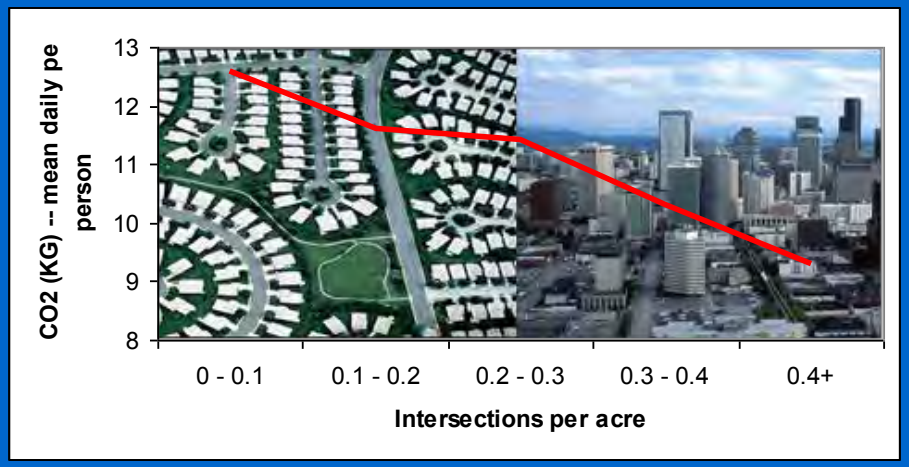
Healthy Foods Access

- Percentage of households within 0.6 miles (1 km) of a grocery store, produce market, specialty market or farmers' market
- Uses Neighborhood Quality of Life Study (NQLS) food outlet data - subject to detailed field verification in 2010.
- Over **80 percent of multi-family households** - and nearly **60 percent of all households** - have access to a grocery store or farmers' market within walking distance.




THE GLOBAL WARMING GAMBLE
FUEL MIX
VEHICLE EFFICIENCY
DEMAND
Policy Levers to Reduce Transportation - Related CO2 emissions

CO2 & Neighbourhood Design

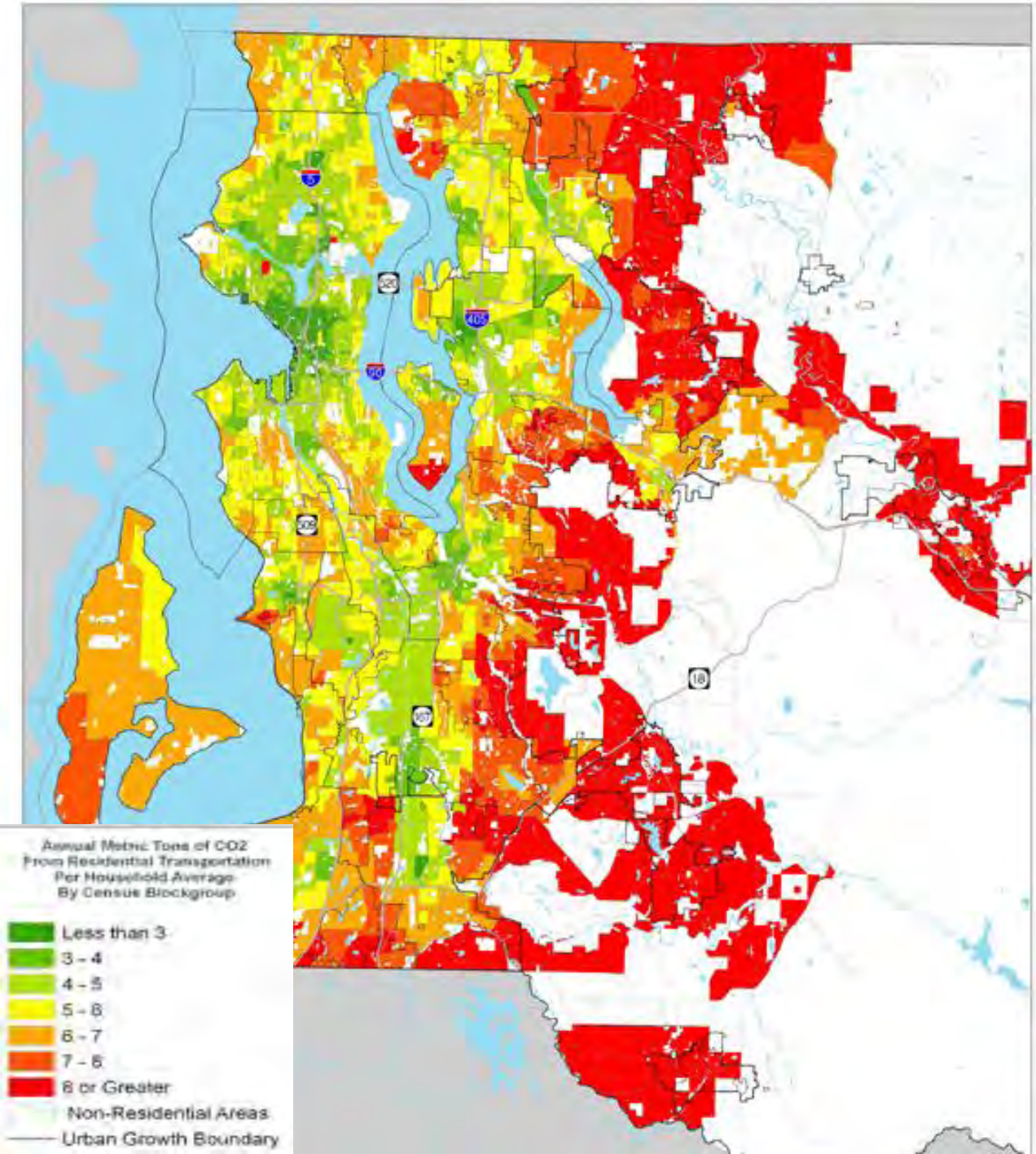


Source: LUTAQH final report, King County ORTP, 2005

Driving 1/3 As Much in 2050

2050 Payoff Scenarios	VEHICLE EFFICIENCY MPG	FUEL MIX GHGs/gal	DEMAND daily VMT per capita
MAJOR PROGRESS	47	-35%	8.4
TECHNOLOGY BREAKTHROUGH	61	-65%	20.9

Brookings Draft Report – King County



Final Map of CO2 emissions from transportation

Includes:

- Local urban form (land use mix, intersection density, retail FAR)
- Regional location (auto travel time
- Transit accessibility & travel time
- Demographics

Results – Urban Form + Major Progress – Seattle Study

- All else equal, households living in the most walkable King County neighborhoods were 54 percent more likely to meet the 8.4 daily mile threshold.
- Each ten-minute decrease in regional transit travel time increased the odds of meeting the vehicle miles traveled target by 11 percent.

Summary

- Document (likely) health care COST$ (auto dominated) and BENEFIT$ of (transit & active) transportation investments
- Working across sectors
  - Research - Integration of health and urban planning research and data collection
  - Practice - Training planners to understand health and health practitioners to understand more about planning
- Zoning *for* Health
  - Health, safety, and welfare underpin development regulations and transportation investments
- Tying Transportation Funding to Measurable Performance

Thank You!

http://health-design.spph.ubc.ca/