Correspondence Section

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
4975 Alliance Drive
Fairfax, VA 22030

CHARLES A. KILPATRICK, P.E.
COMMISSIONER

April 10, 2017

Dear Official:

Subject: Megaproject Briefing and Public Meeting for Six-Year Improvement Program

The Commonwealth Transportation Board (CTB) will conduct a public meeting in your area to give citizens the opportunity to provide comments on projects and programs to be included in the Fiscal Year 2018-2023 Six-Year Improvement Program (FY2018-2023 SYIP), including highway, rail and public transportation initiatives. These projects and programs represent important improvements to address safety, congestion and preservation of Virginia's transportation network.

Your input is also welcomed on the transportation projects scored through the SMART SCALE prioritization process. This process helps determine critical transportation needs through a fair and objective analysis. The SMART SCALE Policy Guide describing the process for the prioritization process is available and can be found at **www.vasmartscale.org**.

The public meeting for citizens in our region will start at 6 p.m. on Wednesday, May 3, 2017 at the District Office, 4975 Alliance Drive, Fairfax, VA 23219. Formal public comment on projects proposed to be included in the draft SYIP and projects that have been scored through the new prioritization process will be accepted at the meeting. Written comments may also be submitted during the meeting, or they may be mailed or emailed afterwards and accepted through May 16, 2017.

Prior to the Norther Virginia District's Six-Year Plan meeting, Secretary Aubrey Layne invites you to attend a briefing starting at 4:30 p.m. to get updates on Northern Virginia's Megaprojects, including the Transform I-66 Inside and Outside the Beltway Projects, and I-395/I-95 Express Lanes Extension Projects. If you plan to attend please RSVP by Friday, April 28 to Michelle Holland at **Michelle.Holland@vdot.virginia.gov** and 703-259-3378.

If you cannot attend the meeting, you may send your comments to Infrastructure Investment Director at 1401 E. Broad Street, Richmond, VA 23219 or email them to **Six-YearProgram@vdot.virginia.gov**. For transit and public transportation you may send your comments **DRPTPR@drpt.virginia.gov**, Public Information Office, Virginia Department of Rail and Public Transportation 600 East Main Street, Suite 2102, Richmond VA, 23219.

Comments on the Draft SYIP and candidate projects will be received until May 16, 2017. For more information, please visit **www.vasmartscale.org** or **www.virginiadot.org/syip.**

I truly appreciate your attendance at this session. If you have any questions prior to the meeting, please contact Maria Sinner 703-259-2342.

Sincerely,

Helen L. Cuervo, P.E.
District Administrator

Enclosure: Public Meetings

VDOT Virginia Department of Transportation | DRPT Virginia Department of Rail and Public Transportation

Public Hearings

Funding the Right Transportation Projects

You are invited to share comments on transportation projects that have been scored and recommended for funding through the SMART SCALE prioritization process based on an objective and data-driven analysis. Additionally, pursuant to §33.2-202, comments will be accepted for new projects valued in excess of $25 million. The Commonwealth Transportation Board will take your comments into consideration as it develops the Six-Year Improvement Program (FY 2018-2023 SYIP). The program allocates public funds to highway, road, bridge, rail, bicycle, pedestrian and public transportation projects. All federally eligible projects in the SYIP will be included in the Statewide Transportation Improvement Program to document how Virginia will obligate its federal funds.

You can can review the list of scored projects as well as those recommended for funding at www.vasmartscale.org.

Public meetings begin at 5:30 p.m. in each of the locations except as noted below:
A formal comment period will be held at these meetings.

Tuesday, March 21, 2017 Salem - Holiday Inn Valley View 3315 Ordway Drive Roanoke, VA 24017	**Wednesday, March 29, 2017** Hampton Roads – Hampton Roads Transportation Planning Organization, 723 Woodlake Drive Chesapeake, VA 23320	**Monday, April 10, 2017** Fredericksburg – Germanna Community College Center for Workforce & Community Education, 10000 Germanna Point Drive Fredericksburg, VA 22408
Thursday, April 13, 2017 Bristol - Southwest Virginia Higher Education Center One Partnership Cir, Abingdon, VA 24210	**Thursday, April 20, 2017** Lynchburg - Lynchburg District Office Ramey Memorial Auditorium 4303 Campbell Avenue, Route 501 Lynchburg, VA 24501	**Tuesday, April 25, 2017** Culpeper - District Office, Auditorium 1601 Orange Road Culpeper, VA 22701
Thursday, April 27, 2017 Staunton – Blue Ridge Community College, Plecker Center for Continuing Education, One College Lane Weyers Cave, VA 24486	**Monday, May 1, 2017** Richmond - District Office Auditorium 2430 Pine Forest Drive Colonial Heights, VA 23834	**Wednesday, May 3, 2017** Northern Virginia - District Office, Potomac Room 4975 Alliance Drive Fairfax, VA 22030 ***Meeting starts at 6 p.m.**

You can also submit your comments by email or mail by May 16, 2017:

For roads and highways: Six-YearProgram@VDOT.Virginia.gov, or Infrastructure Investment Director, Virginia Department of Transportation 1401 East Broad St., Richmond, VA 23219.

For rail and public transportation: DRPTPR@drpt.virginia.gov , Public Information Office, Virginia Department of Rail and Public Transportation 600 East Main Street, Suite 2102, Richmond VA, 23219.

The Commonwealth is committed to ensuring that no person is excluded from participation in, or denied the benefits of its services on the basis of race, color or national origin, as protected by Title VI of the Civil Rights Act of 1964. If you need further information on these policies or special assistance for persons with disabilities or limited English proficiency, please contact the Virginia Department of Transportation's Title VI Compliance Officer at 804-786-2730 or the Virginia Department of Rail and Public Transportation 's Title VI Compliance Officer at 804-786-4440 (TTY users call 711).

Grow Smart Planet
Sustainable "Smart Growth" for the 21st Century

Michael Burrill AICP
578 McAlpin Avenue
Cincinnati, OH 45220

Email: michael@growsmartplanet.org
Phone: 513-260-5258

April 30, 2017

Delegate David Bulova
Virginia House of Representatives
9900 Main Street, Plaza 102
Fairfax, VA 22031

RE: Finance Metro/VRE Extensions to Haymarket without Raising Taxes

Dear Delegate Bulova,

We met in Fairfax in April 2016 to discuss how Northern Virginia could finance extensions of rail transit lines with high capital costs **locally** - ***without raising taxes or waiting years for scarce federal funds.*** The attached documents expand on these ideas.

I am confident that extending the Metro in the I-66 corridor 20 miles west to Haymarket would attract at least ***$2 billion per mile*** in new transit-oriented-development (TOD) near it, comparable to results already achieved for the Metro Silver Line to Tysons Corner and Reston. At ***existing tax rates*** for Fairfax County, in 30 years this would yield:

> ***$7.66 billion per mile*** from new office/commercial areas
> ***$2.5 billion per mile*** from new residential areas

The attached spreadsheet shows how these estimates were calculated. These figures are ***7 to 22 times the $350 million per mile*** budget we would recommend for new elevated rapid transit like those recently built. Rapid transit lines built on grade would cost less (about ***$250 million per mile*** in 2020 dollars). Revenues would be lower in Prince William County because median incomes are somewhat lower than in Fairfax, but still ***more than enough to pay for the Metro and VRE extensions to Haymarket in just a few years.***

We recommend a predesign budget of $30-50 million per mile for the 11-mile extension of VRE from Manassas to Haymarket now entering design development. VRE now attracts about 215 passengers per mile. This extension could attract more riders approaching Gainesville on I-66 and US. 29. Both extensions would make sense because they would reduce traffic congestion on I-66 and give riders two ways to reach employment centers in Arlington, Alexandria, and DC.

Cities planning new transit lines today must face the fact that federal funds now rarely pay more than 25% of total costs. Honolulu citizens and visitors are paying 75% of the $6.7+ billion cost of a 20-mile long elevated rapid transit line with a one-half percent excise tax on all goods and services estimated to yield $4.8 billion in 20 years. FTA funds: $1.55 billion. The federal budget recently proposed includes no funds for transit lines that do not already have FTA funding agreements. The clear message: ***cities must now use local/regional funds.*** This is why a completely new funding approach is now needed for new transit projects.

The goals attachment explains how regions can invest in multi-billion-dollar transit systems ***without using funds needed for other projects and services public officials often consider a higher priority.*** It also explains how future revenues and savings from compact growth near the new lines actually make it easier to fund those line items and consider ***reducing tax rates.***

When we met last year, you asked for inputs on legislative language Virginia might need to approve to help jurisdictions seeking to adopt similar plans. My guess is that the state may now restrict the ability of local jurisdictions to issue bonds in multi-billion-dollar amounts without a guaranteed revenue stream. My recommendation: the state should require local jurisdictions to develop clearly-defined plans and zoning incentives for higher-density development near the new transit lines as "collateral" before bonds could be issued. These plans should be developed by planning organizations at regional level and reviewed by financial "experts" to refine estimates of new tax revenues like those in the attached spreadsheet.

My book documents how much development comparable transit lines have attracted, including several DC region examples, to help local jurisdictions make a strong case for funding new lines.

If I get a positive response to these ideas from you and the others copied below, I plan to send additional copies of the attachments and a similar letter to Metro, MWCOG, VDOT, and other organizations and individuals you might suggest. ***Please let me know what you think!***

Sincerely,

Michael Burrill

Michael Burrill AICP
Community and Transportation Planner
Grow Smart Planet

Atchs:

Grow Smart Planet Goals
Spreadsheet, Finance "Low Carbon" Transportation without Raising Taxes, Northern Virginia

Cc: The Honorable Sharon Bulova, Chair, Fairfax County Board of Supervisors
The Honorable Martin Nohe, Chair, Northern Virginia Transportation Authority (NVTA)
Joseph Swartz, Virginia Railway Express GHX Comments

Finance "Low-Carbon" Transportation Without Raising Taxes
Northern Virginia

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $2 Billion TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	0.89%	17.8	$534

Projected Income Tax Revenues in Millions from $2 Billion TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	State	Local	State	Local	State	Local
Offices/Commercial	36,360	$113,575	5.75%	0.0%	$237.5	$0.0	$7,124	$0
Residential Mix	8,000	$113,575	5.75%	0.0%	$52.2	$0.0	$1,567	$0

Projected Sales and Excise Taxes in Millions from $2 Billion TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	State	Local	State	Local	State	Local
Residential Mix	8,000	$28,394	4.3%	1.7%	9.8	3.9	293	116

30 Years of Tax Revenues in Millions from $2 Billion TOD:

Revenue Sources	Office/Commercial				Residential Mix			
	State	County	City	Totals	State	County	City	Totals
Property Taxes		$534				$534		
Income Taxes	$7,124				$1,567			
Sales and Excise Taxes					$293	$116		
Totals	**$7,124**	**$534**	**$0**	**$7,658**	**$1,860**	**$650**	**$0**	**$2,510**

Total revenues far exceed the capital cost of "low carbon" public transportation per mile (all modes).

Source of Tax Rates: www. 2017 Tax-Rates.Org

Grow Smart Planet
Sustainable "Smart Growth" for the 21st Century

Michael Burrill AICP
Community and Transportation Planner
578 McAlpin Avenue
Cincinnati, OH 45220-1534
Web: www.urbanvis.com; growsmartplanet.org (coming soon)
Email: michael@growsmartplanet.org
Cell: 513-260-5258

The goals of ***Grow Smart Planet*** emerged from the book below. It describes how to plan ***sustainable*** transportation and development to ***preserve resources for future generations.*** It encourages people to live close to work, school, shops, and fun. It describes transportation modes that reduce pollution and use of fossil fuels and operate with lower tax subsidies to achieve both ***environmental*** and ***fiscal sustainability***. It compares driving, buses, ferries, and more than 600 public transit lines: speeds, ridership, capital costs, and farebox recovery rates. It documents development each mode has attracted. It recommends using ***local and regional funds*** to get "low carbon" transportation systems built much faster - ***without raising taxes*** – and explains how.

Sustainable Transportation and Development
Planning/Funding/Results

Michael Burrill AICP, NCARB
Architect, Community and Transportation Planner

Cities seeking funds for new transit lines now spend millions and years developing detailed plans just to seek scarce federal funds that rarely pay more than 25% of capital costs. While they do, costs keep rising. It makes more sense for regions to pay the entire cost of new lines or complete regional transit systems - ***locally*** - and use tax revenues from new development near them to pay off bonds quickly. Compact growth with lively public spaces centered on transit enhances the quality of life ***and attracts new businesses and taxpayers.*** It reduces costs for land, construction, schools, commuting, and public services and allows regions to ***reduce tax rates.*** Most important, it also helps save human life on our planet by ***reducing greenhouse gas emissions.***

Live Close to Work, School, Shops and Fun

We do not have to spend billions to encourage people to reduce their carbon footprints by living close to work, school, shops, and fun. All over the world, you can find cities and towns where people walk, use bikes, and take transit often. Countries like ours invested billions for high-speed highways instead and adopted policies that encouraged people to buy single family homes in outer suburbs. Commutes that once took less than an hour at speed limits now take far longer. Many Americans now want to live closer to places they go often, including jobs in suburbs.

It remains possible to live in low-rise housing with short commutes and a low carbon footprint. I walked or rode a bike to excellent schools or work ***almost half of 62 years***. For ten years, my bus rides averaged 30 minutes. My carpools and solo drives to work were 2-10 miles long and averaged 20-22 minutes. I lived happily without a car for two years in a townhouse that is only a five minute walk away from shops, food, movies, and buses to the regional DC Metrorail system.

My dad taught me to live close to jobs and schools, even in cities with only bus systems. ***Cincinnati and San Antonio are the nation's two largest cities without a regional rail transit system.*** In Cincinnati, we moved from a new home ten miles from work to an older home only 1.7 miles away. ***I rode a bike to work for ten years and cut my driving in half.*** It is no accident my San Antonio apartment was only two miles from work.

Even with a "full court press" to convince more Americans they should simply move closer to their most frequent destinations, ***we may be unable to reduce emissions of greenhouse gases fast enough to stop global warming.*** Our political climate does not yet support taxes on fossil fuels or regulations that restrict their use. If worldwide efforts to reduce population growth are unsuccessful, our small planet will need to support ***two billion*** more people by 2050.

Grow Smart Planet's response: ***create strong economic incentives that encourage more people to voluntarily reduce carbon footprints – by saving them money, creating millions of jobs, and reducing tax rates.*** We do not need more low-rise housing in suburbs 30+ miles from jobs.

Many regions already have attractive pedestrian and bike-oriented neighborhoods with frequent transit service and great schools – in downtowns and suburbs. You do not have to build high-rise buildings everywhere to do this. Most recent Transit-Oriented-Development (TOD) includes a mix of 3-5 story office-retail buildings and housing densities averaging 10-20 dwelling units per acre. This can generate enough riders to support transit. In the 1950s, we lived in a single family home three blocks from Arlington's Columbia Pike. Frequent buses to the Pentagon, downtown, and the DC Metrorail system now serve more bus riders than anywhere else in Virginia.

Mixed-uses and older townhouses near Columbia Pike, Arlington, VA

To achieve these goals, regions must first make an informed choice on transportation modes, reach consensus on routes, and develop plans and incentives to attract TOD near the lines.

Sustainable Driving

Transit advocates must concede that efforts to encourage people to take public transit, ride a bike, or walk often fall on deaf ears. A 2009 Federal Highway Administration survey cited in Chapter 3 of Sustainable Transportation and Development found that 70% of the oil consumed in the U. S. was for transportation, mostly in single-occupant vehicles used for ***82% of all trips.*** More than half of Americans lived in areas with no or very limited transit service. Even in regions with robust, multi-mode regional transit systems, only 10-25% took transit to work.

To reduce use of fossil fuels, we must make driving more sustainable. The strategies below are obvious, but they will all help:

- Increase fuel efficiency
- Increase vehicle occupancy
- Use alternative fuels
- Drive fewer miles
- Design durable vehicles, streets, and highways

The book explores ways to achieve these goals. It also estimates the full cost of driving to allow readers to compare it to the cost of taking transit. It urges raising fuel taxes about 60 cents per gallon to eliminate the funding shortfall to keep roads and bridges in good repair. ***If we do this and fund transit systems locally, it would be easier to convince people to take transit to save thousands of dollars - even if they pay fares high enough to cover all operating costs.***

Walking and Biking

To encourage more people to walk or ride bicycles, we need to redesign suburbs with a compact mix of land uses in close proximity: residential, offices, retail, institutional, sports, recreation, entertainment. Biking is a mainstream mode in many countries and can become one in North America as well. Why? It is low-cost, energy efficient, almost zero pollution – and fun! It attracts people of all ages (I started biking uphill to work at age 50). ***The mode share for biking in five large cities in Europe and Asia is 20-50+%.*** Mode shares in the five most progressive cities and towns here ranged from only 4% to 15.5%. All of them have college campuses.

We also need to make biking in urban and suburban areas safer. ***Protected bike lanes cost far less than other transportation upgrades.*** You should budget about $100,000 per mile for a two-way bike lane with protective barriers like this one on 15th Street in Washington, D.C.

2-way bike lane

Trucks unload and cars park near lane

To encourage biking, more funding for dedicated, protected bike lanes is clearly needed.

Transportation Modes, Performance, and Costs

Chapter 5 of Sustainable Transportation and Development summarizes the performance and costs of more than 600 public transportation lines. Together with Table 3, it defines each mode with photos for readers unfamiliar with transit terms and the wide range of mode choices.

- Table 3 summarizes mode performance, capital costs, and farebox recovery rates
- Table 4 provides performance and capital cost information for each line and mode
- Table 5 provides the construction inflation factors used to convert actual costs into 2011 dollars and inflation factors readers can use to estimate future costs (2012 to 2025)
- Table 6 provides performance, cost and TOD information for each line by location
- Table 7 summarizes TOD in New York City (1979-2016)

Cities that did not seek federal funds for rail transit lines when costs were low (and the federal share of capital costs ranged from 50-80%) are now faced with much higher capital costs per mile. Light rail lines that cost only $7-10 million per mile in the early 1980s now cost about $125 million per mile if they are built on-grade and are bid by 2020. Budgets for elevated lines and subways should be much higher. ***Our budget recommendations for all modes on the next page estimate costs per mile for on-grade, elevated, and underground lines, which vary widely.***

Most planners and public officials presented with today's high capital costs for high-capacity rail transit systems have sticker shock and consider only light-capacity systems with much lower ***capital costs per mile***: buses, Bus Rapid Transit (BRT), commuter rail, and modern streetcars. ***This is a big mistake.*** Planners should instead compare ***boardings per mile*** for each mode (see page 6). Chapter 8 uses boardings to calculate more useful ***capital costs per rider*** (2020 dollars):

Mode	Lines in Operation	Lines in Planning
Bus Rapid Transit	$ 6,706	$ 30,989
Streetcars	$ 18,285	$ 77,026
Monorails	$ 36,808	N/A
Rapid Transit	$ 38,182	$133,534
Commuter Rail	$ 63,158	$185,874
Light Rail	$ 84,550	$115,811
Automated Guideway	$224,887	$341,703

Costs for planned rapid transit lines included high-cost subways in New York; costs for planned light rail lines included lines in two cities with bridges and tunnels. The most surprising result: ***high ridership made monorails and rapid transit more cost-effective than commuter and light rail lines. They were built in corridors with high levels of development.***

Planners should also compare ***farebox recovery rates*** (the share of costs paid by transit riders):

Mode	Range	2011 Average
Bus riders	**8-49%**	**23-36%**
Rapid transit riders	**13-77%**	**66%**
Commuter rail riders	**12-62%**	**52%**
Light rail/streetcar riders	**2-57%**	**30-36%**
Vanpool riders	**53-98%**	**63%**

Average Capital Costs of "Low Carbon" Transportation
Million Dollars per Mile in 2020 Dollars

Transportation Modes	Code	Operating as of 2013		Planned as of 2013		Pre-design Budgets for New Lines		
		# of Lines	Million $	# of Lines	Million $	On-Grade	Elevated	Underground
Dedicated bike lanes	BK	1	**$0.1**	N/A	$0	**$0.15**	N/A	N/A
Bus Rapid Transit	BRT	49	**$16**	22	**$26**	**$30**	N/A	N/A
Electric Trolleybus	TB	45	N/A	0	N/A	**$45**	N/A	N/A
Rapid Transit	RT	76	**$279**	7	**$532**	**$250**	**$350**	**$1,700**
Commuter Rail	CR	94	**$12**	11	**$50**	**$50**	**$350**	N/A
Streetcar Rail	SR	33	**$29**	23	**$68**	**$70**	N/A	N/A
Light Rail Transit	LR	62	**$110**	48	**$230**	**$125**	**$350**	**$1,100**
Automated Guideway	AG	6	**$347**	3	**$313**	N/A	**$350**	N/A
Monorail	MR	6	**$155**	0	$0	N/A	**$350**	N/A
Aerial Tramway	AT	2	**$133**	0	$0	N/A	**$150**	N/A
Cable Car	CC	3	**$45**	0	$0	**$100**	N/A	N/A
Inclined Plane	IP	4	N/A	0	$0	**$100**	N/A	N/A
Ferryboat	FB	3	**$51**	0	$0	**$80**	N/A	N/A

NOTES:

1. **Source: Sustainable Transportaton and Development, Tables 3-5, Michael Burrill, 2014.**
2. **Actual costs for most lines were posted on agency websites (Tables 4, 6-9).**
   Actual costs per mile were adjusted to Jan 2011 dollars using R.S. Means indexes in Table 5.
   Future costs per mile were estimated based on 5% annual inflation using factor (1.551) in Table 5.
3. **Planned Subways in NYC had very deep tunnels and costs estimated at $1.737 billion per mile (2011 $)**
   Subways built close to ground level allow "cut and cover" construction at much lower costs.
   Elevated RT lines in Honolulu, Vancouver, and Virginia had costs estimated at $219 million per mile (2011 $).
   Current technology for RT lines has power near rails, requiring safety barriers that add costs.
   Future technology may allow RT lines to get power from overhead lines, reducing costs per mile.
4. **Planned light rail lines in two cities included bridges and tunnels, increasing average costs per mile.**
5. **Higher capital costs for elevated lines and subways can be offset by automated operation, reducing costs.**
   They also offer the potential of high levels of transit-oriented develoment (TOD) and tax revenues.

Performance of "Low Carbon" Transportation Modes

Transit Lines in Operation in the United States in 2013

Transportation Modes	% Travel	Miles Per Trip	Speed (mph) Range	Speed (mph) Avg	Boardings Per Mile	Farebox Recovery Range	Farebox Recovery 2011 Avg
Bus (MB)	38.9%	4.0	N/A	12.9	72 - 504	8-49%	27.7%
Bus Rapid Transit (BRT)		N/A	8-29	N/A	4,752	16-49%	22.9%
Electric Trolleybus (TB)	0.3%	1.6	7-17	7.1	1,260	18-43%	36.2%
Rapid Transit (RT)	30.4%	4.6	17-41	20.2	14,614	13-77%	66.0%
Commuter Rail (CR)	20.1%	23.4	23-66	32.9	379	12-62%	52.1%
Hybrid Rail (YR)			25-39			3-40%	10.8%
Streetcar Rail (SR)	4.0%	4.8	6-12	15.0	3,196	2-28%	35.6%
Light Rail Transit (LR)			9-38		2,602	12-57%	30.0%
Automated Guideway (AG)	3.5%	N/A	9-20	N/A	3,085	0-8%	10.0%
Monorail (MR)		N/A	16-30	N/A	8,422	114%	
Aerial Tramway (AT)		N/A	12-14	N/A	7,062	N/A	N/A
Cable Car (CC)		N/A	6-7	N/A	4,275	44.7%	44.7%
Inclined Plane (IP)		N/A	4-7	N/A	3,696	29-690%	152.0%
Ferryboat (FB)		6.3	12-16	9.6	3,179	0-143%	23.9%
Vanpool (VP)		34.8	N/A	41.1	N/A	53-98%	63.0%
Demand Response (DR/DT)	2.8%	7.9	N/A	14.9	66	N/A	7.3-10%
Multi-Mode Systems	N/A	N/A	6-55	N/A	N/A	0-102%	26.5%

Comparison to other Countries/Years

Transportation Modes Locations	Years	Miles Per Trip	Speed (mph) Range	Speed (mph) Avg	Boardings Per Mile	Farebox Recovery Range	Farebox Recovery Avg
59 Streetcar/Tram lines, Europe	2013	N/A	8-19	12	7,936	24%	24.0%
430 Lines in 57 US Cities	2010-11	5.3	7-66	25	N/A	0-166%	36.6%
32 Lines in 6 Canadian Cities	2010	N/A	18-35	N/A	N/A		52.7%

NOTES:

1. Source: Sustainable Transportation and Development, Tables 3-4, 10-11, Michael Burrill, 2014.
2. % of Travel, Trip Miles, Average Speeds cited in APTA 2012 Public Transportation Fact Book.
3. Speeds include stops. Range of speeds are for all lines studied in Table 4.
4. Boardings for most systems were cited in APTA Transit Ridership Report, 2nd Qtr 2013. Website sources were used for other lines. Boardings are "unlinked trips." Riders who transfer from one vehicle to another are counted twice. Total riders is lower.
5. Farebox Recovery rates are the share of operating costs paid by transit riders. Systems with high farebox recovery rates reduce operating costs paid by taxpayers.

Corridor Planning and Mode Selection

Chapter 8 of Sustainable Planning and Development describes why it has become so difficult to expand transportation choices in the United States. Planners, public officials, and citizens must work together to consider the costs and benefits of competing transit modes, alignments, and complex planning issues for related development. It often now takes ***decades*** to study transit choices in several corridors, select transit modes, and get voters and local, state and federal agencies to fund them – before detailed design and construction can begin. The process encourages regions to select different modes in each corridor – forcing too many transfers.

Cincinnati, for example, began in-depth multi-million dollar studies of four corridors in 1993. In 2002, officials asked voters in only one county to fund most of a regional light rail and expanded bus system that would serve 2 million people in seven counties. The referendum failed. It took another decade to obtain $148 million for a short streetcar line downtown. After 24 years of planning, a diesel-powered light rail line now estimated at $22 million per mile is still unfunded. ***Cincinnati once had 222 miles of streetcar lines that were built much faster with local funds.***

The bold decision to build ***41,000 miles*** of interstate highways with ***90% federal funding*** in the 1950's also transformed American life much faster than the federal transit planning process allows today. ***The mode choice was already made.*** Most people could see the benefits of driving faster on safer highways to new suburbs or across the country. No one had to vote for local taxes to pay for highways in their region. The highway trust fund created from federal and state fuel taxes made it easy to get new highways built once alignments were determined. By 2006, the total cost of the interstate highway system was $425 billion (about ***$485 billion*** in 2011 dollars). ***If we had spent a comparable amount on public transportation, we would now have 50 cities with regional rapid transit systems, each with about 100 miles of double track lines.***

Chapter 6 and Tables 8-9 of the book describe which modes are most likely to attract Transit-Oriented Development (TOD). Selecting transportation modes for specific corridors and even entire regional systems is no easy task when you consider the wide range of vehicle design and planning concepts. We recommend focusing on the following:

Market Share: What percent of residents are likely to use each mode under consideration?
Miles per Trip: How long are the trips anticipated? What vehicles will offer comfortable rides?
Speed and Frequency: How fast will vehicles go, including stops? How often will they come?
Riders per Mile: How many riders will new lines likely attract? How many per mile?
Capital Costs per Mile and Per Rider: How do these costs compare for competing modes?
Farebox Recovery Rates: What share of operating costs will riders pay?
TOD: How much development will each mode attract? What tax revenues will result?
Environmental: How do modes compare in use of energy/fossil fuels, noise/air pollution?

The book makes it easier to answer these questions. It recommends that time-consuming studies now included in most transportation plans be deferred until ***after*** the transportation mode is chosen and funds are approved. Examples: detailed plans for alignments, stations, land uses, architecture and landscaping, and preservation of historic and natural resources.

The current transportation planning and mode selection process takes far too long. Funding milestones are missed and costs keep rising.

Chapter 8 also explains how to improve corridor planning and the design of transit vehicles and facilities to attract more riders, increase farebox recovery rates, and avoid mistakes in selecting transit modes and vehicle designs. The most common mistake is to assume riders enjoy standing up! Modern streetcars with only 34 seats that cost $3 million don't make sense - even for short trips downtown. They are fast enough to serve the suburbs on dedicated routes, but vehicles must be designed with comfortable seats looking forward for everyone - to attract more riders.

Finance "Low Carbon" Transportation Without Raising Taxes

Planners and public officials familiar with capital and operating costs for new transportation systems cannot easily imagine how they could finance them ***without raising taxes.*** If relatively large regions like Cincinnati could not get voters to support small tax increases for regional rail lines - and took years to get approval of local funds for short streetcar lines - how could they or much smaller regions fund regional multi-mode systems that would cost billions?

The federal government no longer funds a large share of the capital costs of new public transit systems. Revenues generated from fuel taxes are not high enough to keep roads and bridges in good repair - a funding shortfall estimated at only 60 cents per gallon in 2013. Congress refuses to raise federal fuel taxes. The fossil fuel industry may not want more people using "low carbon" transportation - even if this would help save human life on our small planet. Regardless of where you stand on the global warming debate, there are many other reasons to fund transit ***locally***:

- Why should people in one region pay for systems elsewhere they will never or rarely use?
- It is inefficient to send dollars to Washington and wait years to get only some of them back.
- A much simpler transportation planning process is feasible for locally-funded lines.
- We can get more transit lines funded sooner with tax revenues from TOD.

To help planners make informed mode choices and strengthen the case for funding new transit lines locally, we spent a year documenting how much transit-oriented development (TOD) had been built by 2013 near the more than 600 transit lines studied. Most transit and planning agencies had not taken time to encourage TOD or realize the importance of tracking it. We found incomplete or no reliable information for 90% of the lines studied, even for cities like San Diego or Atlanta where a casual glance reveals many new buildings near their transit lines. The good news: ***65 transit lines attracted more than $100 million per mile in TOD:***

Mode	TOD per Mile
38 Rapid Transit/Subway Lines	$100 million to $5.9 billion
10 Modern Streetcar Lines	$118 million to $1.2 billion
13 Light Rail Lines	$138 million to $850 million
3 Bus Rapid Transit Lines	$457 million to $1.0 billion
1 Commuter Rail Line	$127 million

Most streetcar, light rail, and bus rapid transit lines were opened later than the rapid transit lines. ***Development near them continues.*** For example, we counted only $700 million in TOD planned near Cincinnati's short streetcar line ***five years before it opened.*** It is a loop with 3.6 miles of one-way track in a corridor 1.8 miles long. We used corridor length to facilitate comparison to rail lines with dual tracks and yield a TOD cost of ***$389 million per mile***. We excluded costs for two new stadiums and a school that would have been built regardless of the streetcar.

We also excluded $2.7 billion for other projects in early planning. Once they are completed, there will be ***$1.9 billion per mile*** in TOD near a streetcar loop that began running in late 2016.

When calculating future tax revenues from new transit lines, most consultants consider only higher assessments for existing land and buildings as the new lines make property nearby more desirable. Estimates of "value capture" can yield large increases in tax revenues that should not be ignored, but it would be hard to convince anyone to use them to pay off bonds for new transit lines. Our townhouse in Fairfax, VA is four miles from DC Metro lines, but it more than doubled in value in 25 years. My dad's home in Arlington is three miles from the DC Metro, but it is now valued at 24 times what he paid for it in 1954. Tax revenues from higher assessments are usually offset by lower tax rates to make living in desirable areas more affordable. This is why property ***tax rates*** in the Washington region are about half those in Cincinnati. Our home in Fairfax is assessed at twice the amount of our Cincinnati home, but taxes are much lower.

Planners rarely consider tax revenues from new development because they lack information on future plans or consider them too far in the future to count. ***This is a huge mistake.*** One example: the MetroWest planned community with 2,250 dwelling units replaced 69 "postwar bungalows" on 56 acres directly south of the Vienna-Fairfax-GMU Metrorail station. The project has 33 times as many units as the original subdivision. My conservative estimate of the increase in property values: ***$1.3 to $1.9 billion.*** With almost ***2,200 new households,*** it makes also makes sense to consider ***income and sales taxes*** they will pay. A complete analysis would also consider savings achieved by compact growth from projects like this.

To make it easier to estimate tax revenues and savings from TOD in your city, we have estimated what could be built for every $100 million invested (see next page). Regardless of building type, $100 million TOD yields $1 million in annual tax revenues if property is taxed at 1%; it yields $2 million annually if taxed at 2%. In 30 years, property taxes range from ***$15 to $75 million.***

The website www.2017Tax-Rates.Org makes it easier for planners to calculate property, income, and sales tax rates and median incomes for U.S. cities and counties. We have compared them for all cities with rail transit lines and several other cities large enough to finance new regional systems. We were not surprised to find lower property tax rates in most cities with high property values. Ten cities have no income taxes, and one has no sales tax. The spreadsheet on the next page shows the range of income and sales taxes $100 million in TOD would yield in 30 years:

Office/Commercial space	***$93 million to $529 million***
Residential Mix	***$27 million to $143 million***

If a new transit line attracts only $500 million TOD per mile, the tax revenues yielded in 30 years are five times these amounts; at $1 billion per mile, they are ten times these amounts; at $2 billion per mile, twenty times these amounts – ***all far more than new transit line capital costs.***

Finance "Low-Carbon" Transportation Without Raising Taxes

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $100 Million TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	0.5%	0.5	$15
All Building Types	1.0%	1.0	$30
All Building Types	1.5%	1.5	$45
All Building Types	2.0%	2.0	$60
All Building Types	2.5%	2.5	$75

Projected Income Tax Revenues in Millions from $100 Million TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	Low	High	Low	High	Low	High
Offices/Commercial	1,818	$50,000	3.4%	9.7%	$3.1	$8.8	$93	$265
Offices/Commercial	1,818	$60,000	3.4%	9.7%	$3.7	$10.6	$111	$317
Offices/Commercial	1,818	$70,000	3.4%	9.7%	$4.3	$12.3	$130	$370
Offices/Commercial	1,818	$80,000	3.4%	9.7%	$4.9	$14.1	$148	$423
Offices/Commercial	1,818	$100,000	3.4%	9.7%	$6.2	$17.6	$185	$529
Residential Mix	400	$50,000	3.4%	9.7%	$0.7	$1.9	$20	$58
Residential Mix	400	$60,000	3.4%	9.7%	$0.8	$2.3	$24	$70
Residential Mix	400	$70,000	3.4%	9.7%	$1.0	$2.7	$29	$81
Residential Mix	400	$80,000	3.4%	9.7%	$1.1	$3.1	$33	$93
Residential Mix	400	$100,000	3.4%	9.7%	$1.4	$3.9	$41	$116

Projected Sales and Excise Taxes in Millions from $100 Million TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	Low	High	Low	High	Low	High
Residential Mix	400	$12,500	4.5%	9.0%	0.2	0.5	7	14
Residential Mix	400	$15,000	4.5%	9.0%	0.3	0.5	8	16
Residential Mix	400	$17,500	4.5%	9.0%	0.3	0.6	9	19
Residential Mix	400	$20,000	4.5%	9.0%	0.4	0.7	11	22
Residential Mix	400	$25,000	4.5%	9.0%	0.5	0.9	14	27

Source of Tax Rates: www. 2017 Tax-Rates.Org

Planners seeking to apply this approach to real-world examples will find the spreadsheet format on the next page helpful. Cincinnati has enjoyed high levels of development downtown and in uptown in the last 20 years. We are confident that a regional multi-mode rail and bus transit system would attract at least ***$1 billion TOD per mile*** and reduce highway congestion by adding suburban jobs. At ***existing tax rates*** for areas within city limits, in ***30 years*** this would yield

$2.2 billion per mile from new office/commercial areas
$1.08 billion per mile from new residential areas

These figures are almost ***9 to 18 times the $125 million per mile*** predesign budget we would recommend for new light rail transit lines like those in Cincinnati's 2002 MetroMoves plan. Revenues would be lower in counties outside city limits that do not have income taxes, but still ***more than enough to pay for a regional transit system in just a few years.*** If the region continues to plan only short rail transit lines that do not extend to the newer suburbs, the lines will attract fewer riders, riders will be less likely to pay all operating costs, and the region will not save enough money from compact growth to consider reducing tax rates.

We used the same spreadsheet format to estimate tax revenues from TOD in two other areas where we have lived: Northern Virginia and San Antonio. The results confirm that revenues would be high enough to finance extensions of DC Metrorail to suburbs now served by buses. We used a conservative ***$2 billion TOD per mile*** for Northern Virginia, based on recent results for the new Silver Line. We used only ***$1 billion TOD per mile*** for San Antonio. The city attracts two million visitors annually, already has many jobs located in the suburbs, and the airport is only eight miles from downtown. At existing tax rates, in ***30 years*** tax revenues would be:

Location	**TOD Per Mile**	**Tax Revenues from TOD Per Mile**	
		Office/Commercial Areas	**Residential Areas**
Northern VA	$2 billion	$7.66 billion	$2.5 billion
San Antonio	$1 billion	$ 636 million	$ 773 million

The Virginia figures are about ***7 to 22 times the $350 million per mile*** budget we would recommend for new elevated rapid transit lines like those recently built, and still far more than capital costs anticipated for new underground lines. Revenues in San Antonio would be much lower because Texas has no income tax, but they are still ***5 to 6 times the $125 million per mile*** budget we would recommend for on-grade light rail lines that could connect downtown to the airport and suburban jobs with faster service. The transit agency estimated a new BRT line in one corridor to downtown would average ***15 mph*** with stops. Speeds for 62 light rail lines operating in 2013 ranged from ***9 to 38 mph*** with stops (faster in suburbs, slower downtown).

Cities planning to use some of the tax revenues from TOD must concurrently develop master plans showing higher-density development near the lines and encourage it to happen with zoning changes and much lower parking requirements. TOD areas must be clearly defined to help overcome NIMBY objections from existing residents. This is how Arlington was able to attract 76,500 new jobs and $5.9 billion per mile in TOD to just one corridor three miles long, where 18% of the new residents don't own cars and half walk, bike, or take transit to work. Only ***11% of land in this small county was designated for higher-density development.*** Most housing units in Arlington look just like they did in the 1950s. Residents in them still enjoy great schools, high property values, and also have easy access to lively urban areas all over the region.

Cincinnati Ohio Tri-State Region

By 2013, 65 transit lines had attracted $100 million+ per mile in Transit-Oriented Development (TOD):

38 Rapid Transit/Subway Lines	**$100 million to $5.9 billion per mile**
10 Modern Streetcar Lines	**$118 million to $1.2 billion per mile**
13 Light Rail Lines	**$138 million to $850 million per mile**
3 Bus Rapid Transit (BRT) Lines	**$457 million to $1 billion per mile**
1 Commuter Rail Line	**$127 million per mile**

Source: Sustainable Transportation and Development, Chapter 6 and Table 8, Michael Burrill, 2014.

Alternative Building Functions and Primary Building Users for $100 Million in TOD:

Building Functions	Cost	Gross Square Feet (GSF)			Per Dwelling Unit		Total Users	
	Per GSF	Total	Per Unit	Per Adult	Adults	Children	Adults	Children
Offices/Commercial	$275	363,636		200			1,818	
408 Apartment Units	$175	571,429	1400		1.5	0.2	612	82
250 Townhouse Units	$200	500,000	2000		2	0.6	500	150
178 Single-Family Units	$225	444,444	2500		2	1	356	178

Sources: R. S. Means 2017 Square Foot Construction Costs (Cost Per GSF)
Planning Factors per GSF/Dwelling Unit: Michael Burrill

Projected Property Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Property Taxes	
	Rate	Per Yr	30 Yrs
All Building Types	2.0%	20.0	$600

Projected Income Tax Revenues in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Income Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Income	State	City	State	City	State	City
Offices/Commercial	18,180	$62,000	2.64%	2.1%	$29.8	$23.7	$893	$710
Residential Mix	4,000	$62,000	2.64%	2.1%	$6.5	$5.2	$196	$156

Projected Sales and Excise Taxes in Millions from $1 Billion TOD:

Building Functions	Tax	Taxable	Sales Tax Rates		Annual Taxes		30 Years of Taxes	
	Payers	Items	State	City	State	City	State	City
Residential Mix	4,000	$15,500	5.75%	1.25%	3.6	0.8	$107	$23

30 Years of Tax Revenues in Millions from $1 Billion TOD:

Revenue Sources	Office/Commercial				Residential Mix			
	State	County	City	Totals	State	County	City	Totals
Property Taxes		$600				$600		
Income Taxes	$893		$710		$196		$156	
Sales and Excise Taxes					$107		$23	
Totals	**$893**	**$600**	**$710**	**$2,203**	**$303**	**$600**	**$179**	**$1,082**

Total revenues far exceed the capital cost of "low carbon" public transportation per mile (all modes).

Source of Tax Rates: www. 2017 Tax-Rates.Org

Savings from Smart Growth near Public Transportation

Compact medium-density "Smart Growth" near public transportation yields huge savings for families, developers, commuters, public school systems, and public entities responsible for building and maintaining land, infrastructure, and other public services. We have estimated those savings for some big ticket items here, but they are just the tip of the iceberg. Sustainable Transportation and Development also estimates huge savings in energy and greenhouse gas emissions that could help save the planet from global warming while also saving money. The spreadsheet on page 15 estimates auto-related savings.

Capital Costs Avoided if Households Have Only One Car:

Each household would save at least ***$158,460*** in 30 years if they did not have to buy a second car every ten years and costs increased 5% annually. The example uses $30,000 for a car bought in the first year. Savings would be higher if they avoid buying more expensive cars. Households would also save money on parking at home, with garage space costing more than space in surface lots. The range of capital cost savings to households: ***$163,460 to $198,860***. The book also describes related savings in fuel, loan payments, insurance, taxes, tolls, and tags.

Capital Costs Avoided if Employees Do Not Drive to Work:

If employees do not drive to work, employers or public entities do not have to provide parking spaces for them in land wasting surface lots or costly garages. For surface lots this would save about ***$5,000 per car***; for above-ground garages, ***$33,200 per car***; for underground garages, ***$38,400 per car*** (2017 dollars). Savings for 500 cars: ***$2.5 to $19.2 million.*** These savings exclude costs for land, financing, operation and maintenance. If half of the residents in a corridor walk, bike, or take transit to work (as they do near DC Metrorail in Arlington), the number of parking spaces in new office buildings can be reduced significantly. At $202 per GSF, new office space costs $40,400 per employee if they average 200 GSF each. It is very wasteful to spend almost as much for unused parking spaces or cars that do not move most of the day!

Commuting Costs Saved by Wage Earners who Walk, Bike, or Take Public Transit:

A solo driver who commutes ten miles in an energy-efficient car that averages 25 mpg, pays $2.50 per gallon, averages ten cents per mile for maintenance/repairs, and pays $10 to park at work will spend ***$3,500 per year*** for 250 round trips per year. We estimated transit fares at $8 per day for a 20-mile round trip to get ***$2,000 per year.*** Many riders pay lower fares for trips that long (example: only $3.50 in Cincinnati today). Transit riders would save ***$1,500 per year***, or ***$45,000 in 30 years.*** They would save more if they avoid longer commutes by car. Commuters who move close enough to work to walk or take a bike would save ***$102,000 in 30 years.***

Public School Savings from Smart Growth:

The spreadsheet on page 16 estimates public school savings from Smart Growth in a region with land values of $150,000 per acre, 2 million people, and about 728,000 housing units. These savings occur because the average number of public school children living in townhouses and apartments is far less than in single-family units. The $35,000 capital costs for new or fully renovated schools and the $15,500 annual budget per child are based on actual Cincinnati costs.

A region with low-density residential areas averaging ***3.8 units per acre*** would average about ***0.84 public school children per unit*** with a mix of 75% single-family homes, 10% townhouses, and 15% low-rise apartments. This yields 611,520 school children, capital costs, and education costs shown in the first section of the spreadsheet.

A region with medium-density residential areas averaging about ***10.5 units per acre*** would average about ***0.5 public school children per unit*** with a mix of 25% single-family homes, 25% townhouses, and 50% low- rise apartments. This yields 364,000 school children. With 247,520 fewer children, it yields the savings highlighted in green below the second section of the spreadsheet: ***$8.7 billion*** in capital costs and ***$115 billion in education costs in 30 years.***

A region with higher density residential areas averaging about ***17.9 units per acre*** would average only ***0.44 public school children per unit*** with a mix of 10% single-family homes, 40% townhouses, and 50% mid-rise apartments. This yields 320,320 school children. With half as many school children as the low-density residential region, it yields the savings highlighted in green below the third section of the spreadsheet: ***$10.2 billion*** in capital costs and ***$135.4 billion in education costs in 30 years.*** Savings would be higher in TOD residential areas with more apartments, fewer townhouses, and no single-family homes.

For a reality check, we compared education costs per pupil and the number of public school children per unit in Cincinnati and three Northern Virginia counties. We were not surprised to find only ***0.22 children per unit*** in Arlington, VA and ***0.26 children per unit*** in Cincinnati. Both areas have many older single-family homes and apartments. Newer housing that attracts young families with more children usually yields higher numbers. Arlington could afford to spend more money per child ***($18,957)***, thanks to revenues from very high levels of TOD ***($5-5.9 billion per mile).*** ***Schools represent only 33-34% of annual budgets in both areas.***

The City of Fairfax and Fairfax County, VA averaged ***0.51 children per unit.*** These jurisdictions are further from Washington and have many new single-family homes and large townhouses. We combined budgets for both jurisdictions on the spreadsheet because the county operates City of Fairfax schools. ***The school budget is more than half of the combined annual budget,*** even with a budget of ***$14,432*** per child, 9% lower than Cincinnati and 24% lower than Arlington.

Prince William County is even further from Washington, has a higher percentage of single-family homes, and averaged ***0.64 children per unit.*** The school budget was about ***49% of the county operating budget*** despite much lower education costs of ***$10,981*** per child.

These results indicate even moderate increases in density yield big savings in school costs. Not only is Arlington the county with the nation's highest level of transit-oriented development near five miles of DC Metrorail lines, it has high-performing public schools that cost taxpayers less than the schools in suburbs further from Washington. The original plan for the first Metro line serving Arlington was to run trains in the median of I-66 to reduce capital costs. Arlington invested ***$300 million in local funds*** to build Metro lines underground for three miles instead. In the next 40 years, the county gained $17.6 billion in new TOD and 76,500 new jobs in this corridor alone. Property and other tax revenues from TOD are still funding great schools in a county that already had excellent public schools in the 1950s when my family lived there.

Savings from Smart Growth near Public Transportation

Capital Costs Avoided if Households Have Only One Car:

Description	GSF Per Car	# of Cars	Unit Cost	Year	Inflation Rate	Inflation Factor	Total $
Energy-efficient Hybrid car		1	$30,000	2011	5%	1.000	$30,000
Energy-efficient Hybrid car		1	$30,000	2021	5%	1.629	$48,870
Energy-efficient Hybrid car		1	$30,000	2031	5%	2.653	$79,590
Savings in 30 Years							**$158,460**
Parking, surface lot at home	400	1	$12.50	2017	5%	1.000	$5,000
Parking, attached garage at home	200	1	$72	2017	5%	1.000	$14,400
Parking, aboveground garage at home	400	1	$83	2017	5%	1.000	$33,200
Parking, underground garage at home	400	1	$96	2017	5%	1.000	$38,400
Savings in 30 Years						**Low**	**$163,460**
Car Plus Parking Costs at Home						**High**	**$196,860**

Capital Costs Avoided if Employees Do Not Drive to Work:

Description	GSF Per Car	# of Cars	Unit Cost	Year	Inflation Rate	Inflation Factor	Total $
Parking, surface lot at work	400	1	$12.50	2017	5%	1.000	**$5,000**
Parking, aboveground garage at work	400	1	$83	2017	5%	1.000	**$33,200**
Parking, underground garage at work	400	1	$96	2017	5%	1.000	**$38,400**
Parking, surface lot at work	400	**500**	$12.50	2017	5%	1.000	**$2,500,000**
Parking, aboveground garage at work	400	**500**	$83	2017	5%	1.000	**$16,600,000**
Parking, underground garage at work	400	**500**	$96	2017	5%	1.000	**$19,200,000**

NOTES:

1. **Table 5, Sustainable Transportation and Development, has inflation factors for 3% & 5% inflation.**
2. **Construction costs per GSF based on 2017 R. S. Means Square Foot Construction Costs.**
3. **Garages for 10,000+ cars at the University of Cincinnati average about 400 GSF/car.**
   Surface lots with spaces 9 foot wide and driving lanes 25 feet wide average about 400 GSF/car.

Commuting Costs Saved by Wage Earners who Walk, Bike, or Take Public Transit:

Description	Fuel mpg	Miles Per Yr	Gallons Per Yr	Fuel $/gal	M&R Per Mile	Parking $/Day	Total $
Drive 10 miles to work, 250 days/yr	25	5,000	200	$2.50	$0.10	$10	**$3,500**
Public Transit, $8 per day, 250 days/yr	N/A	5,000	N/A	N/A	N/A	$0	**$2,000**
Annual Savings							**$1,500**
Savings in 30 Years							**$45,000**
Walk/bike 2 miles to work, 250 days	N/A	1,000	0	N/A	0.10	0	**$100**
Savings in 30 Years							**$102,000**

NOTES:

1. **Driving costs above do not include car loan payments, insurance, taxes, tolls, or tags.**
   See Table 2, Sustainable Transportation and Development for all monthly driving costs
2. **Estimated $8 per day for transit fares is for a 20-mile round trip. Many riders pay lower fares.**

Public School Savings from Smart Growth near Public Transportation

Land Values:	**$150,000**	**Per Acre**
Population:	**2,000,000**	**Persons**
Housing Units:	**728,000**	**Estimated @ 2.75 persons/unit (US/Canada average)**
Capital Budget:	**$35,000**	**Cost of new or fully-renovated schools per child**
Education budget:	**$15,500**	**Annual operating budget per child**

Planning Factors	Land $ Per Acre	Mix %	Per Acre	Total Acres	Total Units	School Children Per Unit	School Children Total	Capital $ Millions	Education (Million $) Annual	Education (Million $) 30 Yrs
Single-Family homes	$150,000	**75%**	**3**	182,000	546,000	**1.0**	546,000	$19,110	$8,463	$253,890
Townhouses	$150,000	**10%**	**10**	7,280	72,800	**0.6**	43,680	$1,529	$677	$20,311
Apartments	$150,000	**15%**	**25**	4,368	109,200	**0.2**	21,840	$764	$339	$10,156
Low-Density Residential			**3.8**	**193,648**	**728,000**	**0.84**	**611,520**	**$21,403**	**$9,479**	**$284,357**
Single-Family homes	$150,000	**25%**	**5**	36,400	182,000	**1.0**	182,000	$6,370	$2,821	$84,630
Townhouses	$150,000	**25%**	**10**	18,200	182,000	**0.6**	109,200	$3,822	$1,693	$50,778
Apartments	$150,000	**50%**	**25**	14,560	364,000	**0.2**	72,800	$2,548	$1,128	$33,852
Medium-Density Residential			**10.5**	**69,160**	**728,000**	**0.50**	**364,000**	**$12,740**	**$5,642**	**$169,260**
Savings							**247,520**	**8,663**	**$3,837**	**$115,097**
Single-Family homes	$150,000	**10%**	**8**	9,100	72,800	**1.0**	72,800	$2,548	$1,128	$33,852
Townhouses	$150,000	**40%**	**12**	24,267	291,200	**0.6**	174,720	$6,115	$2,708	$81,245
Apartments	$150,000	**50%**	**50**	7,280	364,000	**0.2**	72,800	$2,548	$1,128	$33,852
Higher-Density Residential			**17.9**	**40,647**	**728,000**	**0.44**	**320,320**	**$11,211**	**$4,965**	**$148,949**
Savings							**291,200**	**10,192**	**$4,514**	**$135,408**

NOTES:

1. **Land costs widely. We estimated values for 24 locations based on median home values cited in 2017 Tax-Rates.Org. Values ranged from $133,380 per acre in Hamilton County, OH to almost $8 million per acre in Manhattan, NYC.**
2. **Capital costs estimated based on recent major capital investments in Cincinnati, OH. They exclude land costs.**
3. **Number of public school students per unit based on studies for new housing in Montgomery County, PA/Connecticut. Students per unit generated found in most zoning regulations are much higher than real-world numbers.**
4. **Costs per pupil also vary, even within one region. Examples from Cincinnati and Washington Area Board of Education:**

Public School District	Total Cost Per Pupil	Fiscal Year	Total Units	School Children Per Unit	School Children Total	Annual Budgets (Million $) Schools	City/Cty	Total	% Schools
Cincinnati, Ohio (CPS)	**$15,503**	2016-7	133,420	**0.26**	35,000	$543	$1,053	$1,596	**34.0%**
Arlington County, VA	**$18,957**	2016-7	112,529	**0.22**	25,302	$463	$943	$1,406	**32.9%**
Fairfax County & City, VA	**$14,432**	2016-7	368,091	**0.51**	185,979	2,684	$2,064	$4,748	**56.5%**
Prince William County, VA	**$10,981**	2016-7	137,115	**0.64**	88,117	526	$544	$1,070	**49.2%**

In Northern Virginia, the number of students per unit is much higher in outer suburbs with more single family homes.
Arlington County is the suburb closest to Washington with high levels of development near the DC Metro.
Fairfax County is a suburb further away with more than a million residents. Some areas have bus service to the DC Metro.
Prince William County is a low-density outer suburb that also had $140 million in school capital projects in FY 2016-17.

Savings from Smart Growth in a Region of 2 Million People

The spreadsheet on the next page estimates capital cost savings from Smart Growth in a region with land values of $150,000 per acre, two million people, 728,000 housing units, 910,000 wage earners, and 182 million GSF of office/retail space.

The first section estimates total GSF, acres, and capital costs for land and construction if this space is built at low densities, with residential areas averaging ***3.7 units per acre***, 2-4 story office/retail buildings, and surface parking at home and work.

The second section estimates comparable costs if this space is built at medium densities, with residential areas averaging ***10 units per acre*** and 2-4 story office/retail buildings. Half of the parking spaces for townhouse and apartment residents would be in surface lots and half in above-ground garages. Half of the parking spaces at work would be in surface lots and half in above-ground garages. The savings from medium-density development are highlighted in green:

189 million GSF of space
175,116 acres of land valued at $26.3 billion dollars
$64.3 billion in construction costs

The third section estimates comparable costs if this space is built at higher densities, with residential areas averaging ***17.3 units per acre*** and 5-10 story office/retail buildings. Only 25% of the parking spaces for townhouse/apartment residents would be in surface lots; 75% would be in underground garages. Only 25% of the parking spaces at work would be in surface lots; 75% would be in underground garages. Savings from higher-density development are in green:

200 million GSF of space
219,770 acres of land valued at $33 billion dollars
$40.5 billion in construction costs

In a region with land values of $450,000 per acre, savings for land would be higher:

$78.8 billion from medium-density development
$98.9 billion from higher-density development

Private-sector developers and residents would save most of this money, but the public sector could have similar savings. Multi-story public buildings and schools designed to serve more students would cost less if designed with fewer parking spaces because they are near public transit. Arlington County's offices are next to a Metro stop (see photo on page 1, lower right).

The spreadsheet can be used to estimate savings in energy, operation and maintenance, and public costs for streets, utilities, police and fire protection. Two million people in 728,000 housing units at 10 units per acre would use only ***37% as much land*** as they would at 3.7 units per acre, or only ***21% as much land*** at 17.3 units per acre – ***even with all units the same size.*** Townhouses and apartments save energy because they have less outside wall area than single-family homes; usually they are much smaller. ***Savings in transportation costs and greenhouse gas emissions would be huge too.*** It would be easy for people to live closer to work, schools, shops, fun, and to walk, bike, or take transit (or have much shorter commutes in cars).

Savings from Smart Growth near Public Transportation

Land Values: $150,000 Per Acre
Population: 2,000,000 Persons
Housing Units: 728,000 Estimated @ 2.75 persons/unit (US/Canada average)
Wage Earners: 910,000 Estimated @ 1.25 per housing unit
Office/Retail Space: 182 Million GSF (average 200 GSF/wage earner)

Planning Factors	Land $ Per Acre	Mix %	Per Acre	Unit GSF	Million GSF	Units Spaces	Total Acres	$ Per GSF	Totals (Million $) Land	Constr
Single-family homes	$150,000	75%	3	2,500	1,365	546,000	182,000	$200	$27,300	$273,000
Townhouses	$150,000	10%	10	2,000	146	72,800	7,280	$175	$1,092	$25,480
Apartments	$150,000	15%	25	1,400	153	109,200	4,368	$196	$655	$29,964
Surface parking, TH/APTS	$150,000	100%	109	400	73	182,000	1,671	$12	$251	$874
Residential Areas			3.7		1,736	910,000	195,319		$29,298	$329,318
Office/retail space (2-4 stories)	$150,000		10,000		182		18,200	$202	$2,730	$36,764
Surface parking, work	$150,000	100%	109	400	364	910,000	8,356	$12	$1,253	$4,368
Subtotals, Office/Residential					2,282	1,820,000	221,876		$33,281	$370,450
Streets/utilities (+25%)	$150,000				0		55,469		$8,320	$92,613
Low-Density Growth					2,282		277,344		$41,602	$463,063
Single-family homes	$150,000	25%	5	2,500	455	182,000	36,400	$200	$5,460	$91,000
Townhouses	$150,000	25%	10	2,000	364	182,000	18,200	$175	$2,730	$63,700
Apartments	$150,000	50%	25	1,400	510	364,000	14,560	$196	$2,184	$99,882
Surface parking, TH/APTS	$150,000	50%	109	400	109	273,000	2,507	$12	$376	$1,310
Aboveground garages, TH/APTS	$150,000	50%	218	400	109	273,000	1,253	$83	$188	$9,064
Residential Areas			10.0		1,547	1,274,000	72,920		$10,938	$264,956
Office/retail space (2-4 stories)	$150,000		50,000		182		3,640	$202	$546	$36,764
Surface parking, work	$150,000	50%	109	400	182	455,000	4,178	$12	$627	$2,184
Aboveground garages, work	$150,000	50%	436	400	182	455,000	1,045	$83	$157	$15,106
Subtotals, Office/Residential					2,093	2,184,000	81,783		$12,267	$319,010
Streets/utilities (+25%)	$150,000				0		20,446		$3,067	$79,752
Medium-Density Growth					2,093		102,229		$15,334	$398,762
Savings					189		175,116		$26,267	$64,301
Single-family homes	$150,000	10%	8	2,500	182	72,800	9,100	$200	$1,365	$36,400
Townhouses	$150,000	40%	12	2,000	582	291,200	24,267	$175	$3,640	$101,920
Apartments	$150,000	50%	50	1,400	510	364,000	7,280	$234	$1,092	$119,246
Surface parking, TH/APTS	$150,000	25%	109	400	66	163,800	1,504	$12	$226	$786
Underground garages, TH/APTS	$150,000	75%	N/A	400	197	491,400	0	$96	$0	$18,870
Residential Areas			17.3		1,536	1,383,200	42,151		$6,323	$277,222
Office/retail space (5-10 stories)	$150,000		100,000		182		1,820	$184	$273	$33,488
Surface parking, work	$150,000	25%	109	400	91	227,500	2,089	$12	$313	$1,092
Underground garages, work	$150,000	75%	N/A	400	273	682,500	0	$96	$0	$26,208
Subtotals, Office/Residential					2,082	2,293,200	46,060		$6,909	$338,010
Streets/utilities (+25%)	$150,000				0		11,515		$1,727	$84,503
Higher-Density Growth					2,082		57,575		$8,636	$422,513
Savings					200		219,770		$32,965	$40,550

NOTES:

1. **Land costs per acre vary. See estimates for 24 locations based on median home values cited in 2017 Tax-Rates.Org.**
2. **Construction costs per GSF based on 2017 R.S. Means Square Foot Construction Costs.**
   Costs for single-family homes includes 2-car attached garage. Garage cost: $14,360 per space.
3. **25% allowance for streets and utility lines is based on cost analyses for large subdivisions and planned communities.**

Think Globally, Act Locally

Grow Smart Planet has identified 27 regions with a total population of 38.6 million that are large enough to support regional rail transit systems with crosstown feeder bus routes. Most of them have no rail lines or just a short "starter" line now. Many other cities have rail transit lines serving several areas, but are considering extensions or crosstown routes that remain unfunded. ***The role we would like to play is simply to spread these ideas to as many regions as possible.*** We anticipate many regions will be able to take the ball and run with it without spending a fortune on costly planning and engineering consultants. This will be easier if they order a few copies of Sustainable Transportation and Development and get the right people to read it. If demand is high enough, we plan to go to print again soon.

Grow Smart Planet is a big fan of Chicago architect Daniel Burnham, who said **"Make No Little Plans"** and then helped implement big plans there and in Washington, D.C. His words have inspired us to take on this challenging task because far too many people still do not think global warming is a huge problem for human life on earth. They oppose solutions like carbon taxes and birth control that would clearly help, or they think solving it will slow economic growth or cost billions in new taxes (at the expense of other important needs). They do not realize we have already spent billions coping with the impacts of climate change, and we will soon spend trillions more on stop-gap mitigation efforts like flood controls in coastal cities. ***It would cost far less to reduce energy demand in buildings and transportation to help solve the many core environmental problems caused by our excessive use of fossil fuels.***

We are lucky that most countries with rapidly expanding populations use less energy and carbon-based fuel per person than the United States or other countries where auto-oriented "suburban sprawl" accurately describes current development patterns. Our goal is to transform existing cities and suburbs into more compact mixed-use areas focused on "low-carbon" transportation corridors, allowing both to attract new businesses and residents at much lower costs. We are confident low-density communities nationwide can follow Arlington's example and transform themselves into highly-desirable places to live where 50% of their residents walk, bike, or take transit. They can work in energy-efficient new or renovated offices, live in homes powered by renewable energy, or have short commutes to jobs only accessible by car.

Let's simply cut our use of energy and greenhouse gas emissions in half by 2030.

Grow Smart Planet hopes ***you will now take actions*** that will convince public officials, planners, and residents in your city to plan new ***regional*** "low carbon" transportation systems and transit-oriented development where people can easily live close to work, schools, work and fun; use less energy at home, work, and while commuting; and reduce greenhouse gas emissions.

Convince them that property and other tax revenues from new businesses and residents will be enough to ***pay the full capital cost of the new transportation systems with local funds in just a few years***, and will be the "gift that keeps on giving" for decades to come.

Convince them they do not have to choose between paying for regional transportation systems and budget items they may think are more important. ***They can have their cake and eat it too.*** Why? The revenues from TOD will come from taxes on ***new*** property and ***new*** residents (as well

as new jobs created during construction). Even if some of the people living and working in the new buildings move from elsewhere in the same region, the homes and buildings they leave will soon be filled by other taxpayers. This is why it would make sense to use tax revenues generated by new buildings and taxpayers ***in TOD zones*** to pay off bonds used for capital costs quickly.

Convince them that the new tax revenues and huge savings from Smart Growth ***will allow them to spend more money on worthwhile projects and services and still reduce tax rates in the future***, just as most regions that already have regional transit systems have done.

Convince them that it makes more sense to invest billions for a regional rail and high-speed bus transit system than to simply expand bus service ***because riders on faster, region-wide rail systems will pay a much higher share of operating costs.***

Convince them it no longer makes sense to compete with other cities seeking scarce federal funds, which requires preparation of costly, complex planning and environmental studies. Conceptual planning studies that focus on the "big picture" mode selection and corridor planning decisions outlined here and in Sustainable Transportation and Development would cost far less.

Convince them that ***they do not need to give tax breaks to developers proposing projects located near new transit lines.*** The new transit lines bring workers and customers to their doors and allow developers to build more usable space with fewer high-cost parking spaces. The regional transit system will make their properties more desirable and profitable – ***without tax breaks.*** This will require a change in mindset for public officials and developers in most cities, but it is not without precedent. Developers will line up for the opportunity to build mixed-use projects with higher densities near new rail transit lines - if they know these areas have already been planned for growth - and it will not take years to get approval of specific projects.

Convince local residents they will not be asked to pay for the capital costs of the new transit lines, and higher-density development will only occur within the boundaries designated. Explain they will benefit from higher property values (with lower tax rates), higher tax revenues for schools and other services, and a faster transportation system than buses stuck in traffic.

Convince state lawmakers and bankers to allow cities and suburbs to issue bonds to cover capital costs of multi-billion-dollar regional systems because revenues from TOD near the lines will be more than enough to pay the bonds back in just a few years. Use plans for TOD as collateral.

If you live in a city that already has a regional rail and bus transit system, convince public officials that they should support plans to replace outmoded trains, buses, and bus shelters; upgrade transit stations; improve schedules and routes; and take other actions that will attract more riders and improve farebox recovery rates. The book describes many ways to do this. Most cities with existing rail systems could finance these upgrades from new TOD near existing lines and extensions to outer suburbs or new crosstown routes – ***without raising taxes.***

Grow smart. Save big. Help save the planet from the adverse impacts of global warming.

We welcome your comments and questions!