



Not So Smart

Land Consumption in Maryland
After a Decade of "Smart Growth"



Not So Smart

Land Consumption in Maryland After a Decade of “Smart Growth”

Environment Maryland
Research & Policy Center

Written by:
Mike Sherling and Brad Heavner,
Environment Maryland Research & Policy Center

Tony Dutzik and Elizabeth Ridlington,
Frontier Group

March 2009

Acknowledgments

The authors thank Erik Fisher of the Chesapeake Bay Foundation, Gerrit Knaap of the National Center for Smart Growth, and Cindy Schwartz of the Maryland League of Conservation Voters for their insightful comments and suggestions. Thanks also to the Maryland Department of Planning for their gracious assistance. Finally, thanks to Susan Rakov and Sarah Payne of Frontier Group for their editorial support.

Environment Maryland Research & Policy Center thanks the Abell Foundation, the Fund for Change, the Zanzyl & Isabelle Krieger Fund, the Rauch Foundation, and the Town Creek Foundation for making this project possible.

The authors bear responsibility for any factual errors. The recommendations are those of Environment Maryland Research & Policy Center. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided editorial review.

Copyright 2009 Environment Maryland Research & Policy Center

The Environment Maryland Research & Policy Center is a 501(c)(3) organization. We are dedicated to protecting Maryland's air, water and open spaces. We investigate problems, craft solutions, educate the public and decision-makers, and help Marylanders make their voices heard in local, state and national debates over the quality of our environment and our lives. www.environmentmaryland.org

Frontier Group conducts research and policy analysis to support a cleaner, healthier and more democratic society. Our mission is to inject accurate information and compelling ideas into public policy debates at the local, state and federal levels. www.frontiergroup.org.

Cover photos: Satellite image of Baltimore-Washington, D.C., area: National Aeronautics and Space Administration, Visible Earth, visibleearth.nasa.gov; Housing development: Melissa Carroll, istockphoto.com.

Layout: Harriet Eckstein Graphic Design

Table of Contents

Executive Summary	1
Introduction	5
The Impacts of Sprawl in Maryland	6
Declining Water Quality in the Chesapeake Bay	6
Water Shortages	7
Habitat Fragmentation	8
Loss of Scenic and Historic Areas	9
Long Commutes and Reduced Quality of Life	9
Global Warming Pollution	9
Development Continues to Consume Vast Amounts of Land in Maryland	11
Land Consumption Continues at a Rapid Pace	11
Development Is Consuming Significant Amounts of Land per Person	13
Development Continues to Push into Formerly Rural Areas of Maryland	17
Residential Development Is Driving Increased Land Consumption	18
Development Outside Priority Funding Areas Consumes Large Amounts of Land	19
Smart Growth Policy in Maryland: What Has Gone Wrong and How Can We Fix It?	24
Methodology	26
Notes	29

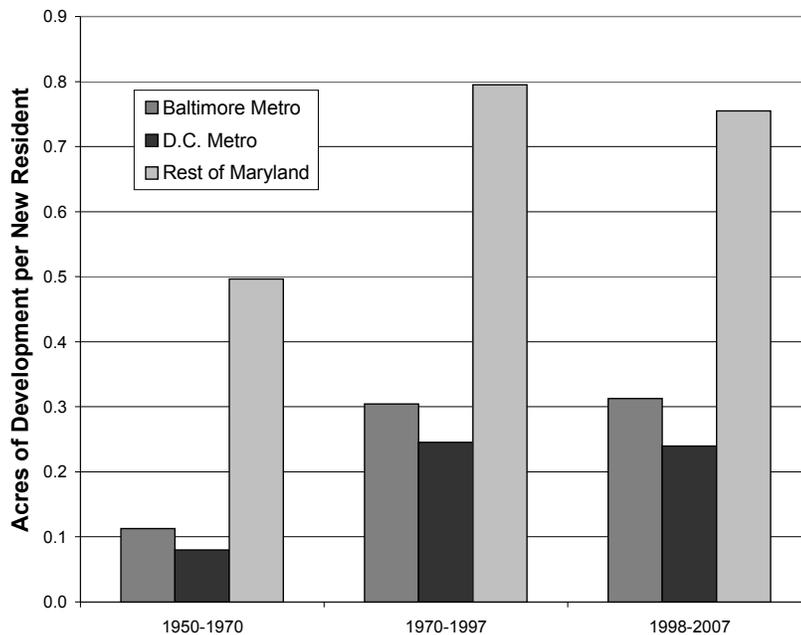
Executive Summary

Spawning development has continued in Maryland in the decade since the enactment of the state's smart growth laws. Indeed, the pace of land development for residential and commercial uses has been essentially unchanged compared to the decades immediately prior to the launch of Maryland's smart growth strategy.

Commercial and residential development continues to consume vast amounts of land in Maryland.

- Since 1998, the year after the enactment of Maryland's smart growth laws, more than 175,000 acres have been consumed for residential or com-

Figure ES-1. Acres of Commercial/Residential Development per New Resident



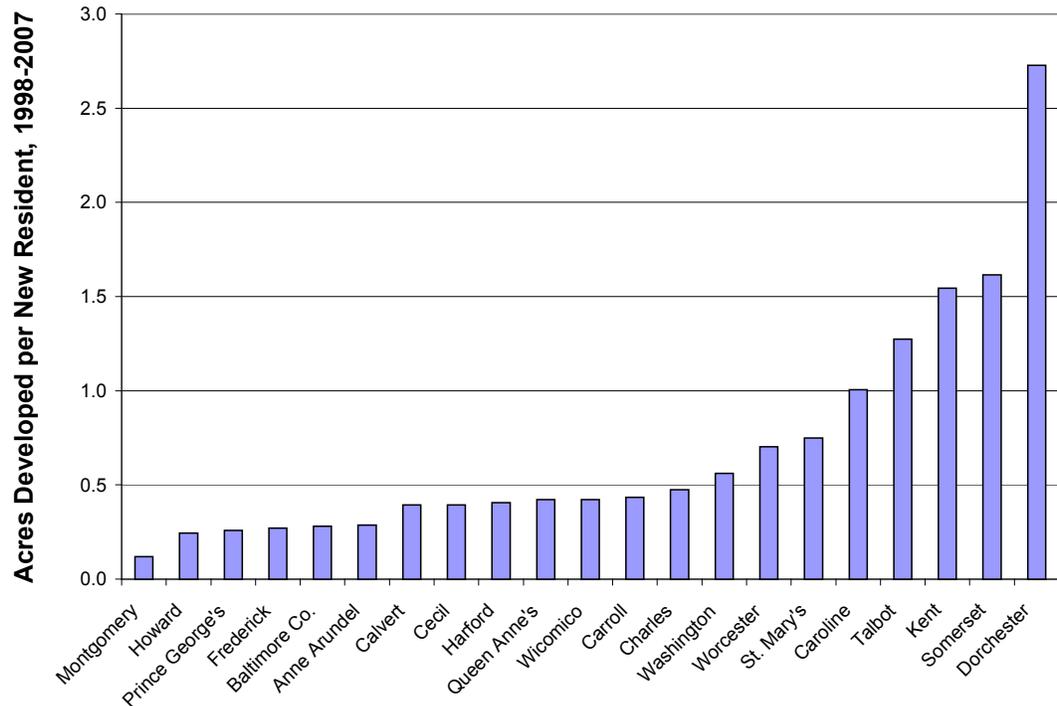
mercial development – an area three times as large as Baltimore City.

- New commercial and residential development in Maryland since the beginning of 1998 has consumed more than one-third of an acre per new resident. The rate of land consumption per new resident from 1998 to 2007 was virtually the same as it was between 1970 and 1997. Residential and commercial development in Maryland consumes approximately three times as much land per new resident as it did in the period from 1950 to 1970.
- Among Maryland’s metropolitan counties, Charles County had the highest rate of land consumption per new resident since 1998, at 0.47 acres per person, followed by Carroll

and Harford counties. Fast-growing St. Mary’s County, which is just outside of the Census Bureau-defined boundaries of the Washington, D.C., metropolitan area, experienced an even higher rate of development, at 0.75 acres per new resident.

- The rate of land consumed per new resident was lowest in Montgomery County, at 0.12 acres per new resident, followed by Howard and Prince George’s counties.
- The amount of land consumed per new resident increased in several of Maryland’s metropolitan counties since 1998 compared with the period between 1970 and 1997. Anne Arundel County experienced a 41 percent increase in land consumption per

Figure ES-2. Acres Developed for Residential or Commercial Use per New Resident, 1998-2007 (Counties with Population Loss Omitted)



new resident, with Harford County experiencing a 27 percent increase and Charles County a 17 percent increase.

- However, several Maryland counties significantly reduced the amount of land consumed per new resident since 1998. Cecil County reduced the amount of land consumed for residential and commercial development per new resident by 39 percent compared with the 1970-97 period. Calvert, Frederick, Baltimore, Montgomery and Carroll counties each experienced reductions of 10 percent or more in land consumption per new resident.

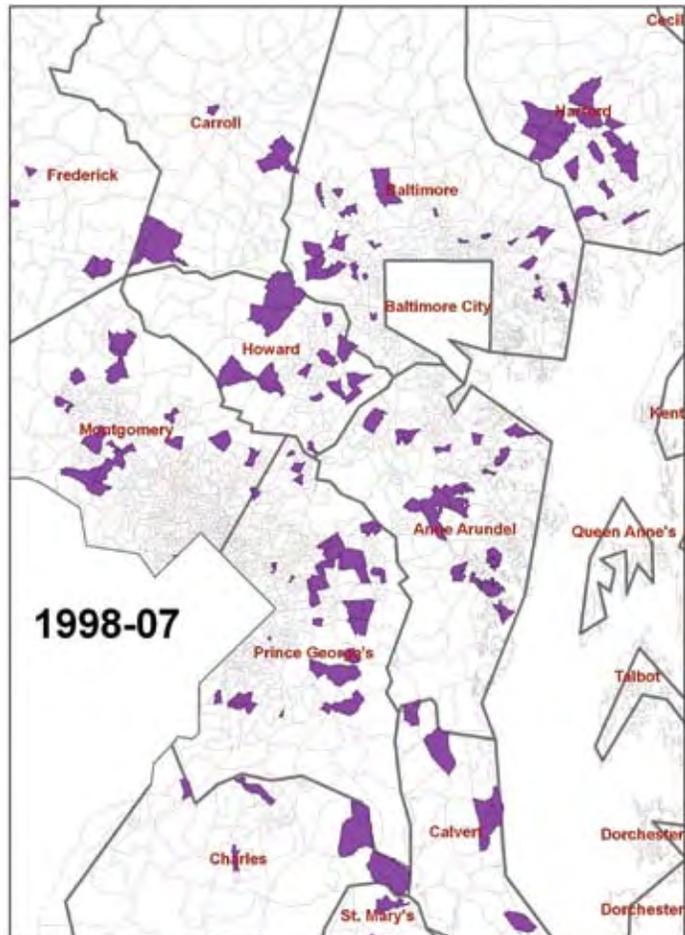
Sprawling development continues to push its way into formerly rural regions of Maryland.

- Several areas of Maryland have exhibited rapid development since the beginning of 1998. Commercial and residential development claimed nearly 7 percent of the land area of Howard County and more than 5 percent of the land area of Calvert and St. Mary's counties.
- Residential development has been a key contributor to sprawl in several counties. In areas such as Frederick, Carroll, Calvert, Charles and St. Mary's counties, residential development consumed an average of more than one acre per new residential parcel (excluding condominiums and apartments and residential units on lots of 20 acres or more).

Maryland's smart growth laws show the potential benefits of well-planned development, but have not been enough to contain sprawl.

- New homes built within approved Priority Funding Areas (PFAs) consistent

Figure ES-3. Areas Where More than 10 Percent of Land Was Converted to Residential or Commercial Development Between 1998 and 2007



with Maryland's smart growth laws consumed one-seventh the amount of land, on average, as homes built outside of PFAs. If all Maryland homes built after the beginning of 1998 used the same amount of land as those built within approved PFAs, the state could have kept 100,000 acres of land from being developed.

- Two-thirds of new residential *parcels* developed since 1998 have been within the boundaries of approved PFAs. However, the vast majority of new acres of residential *land* (77 percent)

were developed outside approved PFAs.

To contain future sprawl, and improve the environment and quality of life, Maryland must put teeth into its planning, zoning and smart growth laws.

- County comprehensive plans, developed with the input and participation of the public, often reflect a sustainable vision for community development. Unfortunately, the plans are not well enforced. The link between county zoning maps and the contents of local plans is not strong enough. Maryland should set a mandatory timeline for counties to change zoning maps to match the comprehensive plan and

limit loopholes and exemptions for development that contradicts the plan.

- The state should strengthen enforcement of the state's smart growth laws and withhold transportation and other funding from counties that fail to adopt and enforce comprehensive plans that appropriately focus future growth.
- Maryland should adopt a state development plan to guide future growth, develop measurable goals and means of assessing progress toward their achievement, align state investment priorities with those goals, and target state funding to local governments whose plans align with the state growth management objectives.

Introduction

For decades, sprawling development has been among the most pressing environmental challenges facing Maryland. Wave after wave of housing developments, shopping malls and other forms of development—often poorly planned—consumed vast amounts of land, contributed to run-off pollution of waters feeding the Chesapeake Bay, fed traffic congestion, increased our contribution to global warming, and eroded Marylanders’ quality of life.

At the moment, the days of run-away suburban growth seem like a distant memory. The housing market and commercial real estate markets have retrenched. The urgency of preventing unwise growth has been eclipsed by the urgency of keeping Marylanders in their homes.

But the current “time out” in development won’t last forever. By 2030, Maryland’s population is projected to increase by 27 percent, adding 1.4 million new people.¹ The Base Realignment and Closure (BRAC) process, coupled with the continued role of the federal government as

an economic engine for the region, make it more likely that growth will continue in Maryland in the years to come regardless of the state of the broader economy.

Now is the perfect time for Maryland to evaluate the development that has occurred during the recent boom—and establish policies to ensure that the mistakes of the past aren’t repeated.

This report shows that land consumption for development has continued in Maryland, even following the passage of the state’s landmark smart growth laws in 1997.

While those laws and policies have been innovative and made some inroads into encouraging more sustainable development, they have not been enough to stop the onward march of development across Maryland.

To protect our remaining open spaces, preserve water quality in the bay, meet the state’s goals for reducing global warming pollution and protect Marylanders’ quality of life, we need a fresh approach to prioritizing smart growth and curtailing sprawl.

The Impacts of Sprawl in Maryland

Almost all new residential and commercial development in Maryland occurs in open space; very few new projects are redevelopment efforts in urban areas. Within the Chesapeake Bay watershed, 64 percent of new development occurs on agricultural land and 33 percent occurs on forests.²

For Maryland, this translates to a loss of 25,000 acres of farmland and forest to development each year.³ From 1990 to 2000, counties in central Maryland experienced the fastest loss of farmland: Anne Arundel, Baltimore, Howard, Montgomery and Prince George's counties lost 2.6 to 6.2 percent of their agricultural land in that decade.⁴ Today, the fastest loss of farmland is occurring in southern Maryland.

The loss of farms and forests has multiple consequences, including declining water quality in the Chesapeake Bay, water supply problems, habitat fragmentation, the destruction of scenic and historic sites, increased global warming pollution and erosion of Marylanders' quality of life.

Declining Water Quality in the Chesapeake Bay

Water quality in the Chesapeake Bay has been declining for decades. Over those same decades, the states in the Chesapeake Bay watershed have experienced tremendous amounts of low-density development that has increased stormwater runoff into the bay.

Development in the watershed degrades the bay's water quality by destroying forests, open space and wetlands that filter contaminants from rain and melting snow. In an undeveloped area, rain soaks into the ground, where it is gradually released into streams or aquifers. Sediment, nutrients and many other pollutants are trapped by the soil and thus do not enter waterways.

Development replaces these natural filters with hard surfaces. Rooftops, parking lots and roadways channel water and pollutants—together known as stormwater—into the streams and rivers that feed the bay. Stormwater pollution accounts for 17 percent of phosphorus pollution, 11 percent of nitrogen pollution, and 9 percent of sediment pollution in the bay.⁵ As a new development is being constructed,

sediment pollution from the building site may be 10 to 20 times greater than from agricultural land.⁶

Low-density development and development far from existing population centers require more impervious surfaces and thus trigger more stormwater runoff into the bay. According to the Chesapeake Bay Program, a multi-state partnership that studies the bay, stormwater runoff is the fastest growing source of bay pollution.⁷

New development in the bay watershed has caused a rapid increase in impervious surface cover. From 1990 to 2000, development added 250,000 acres of rooftops, parking lots and roadways, a 41 percent increase in impervious surface area in the region.⁸ As of 2000, many Maryland watersheds that abut the western side of the Chesapeake Bay were 12 to 42 percent covered in hard surfaces.⁹ (See Figure 1). Water quality suffers when as little as 5 percent of an area is covered.¹⁰

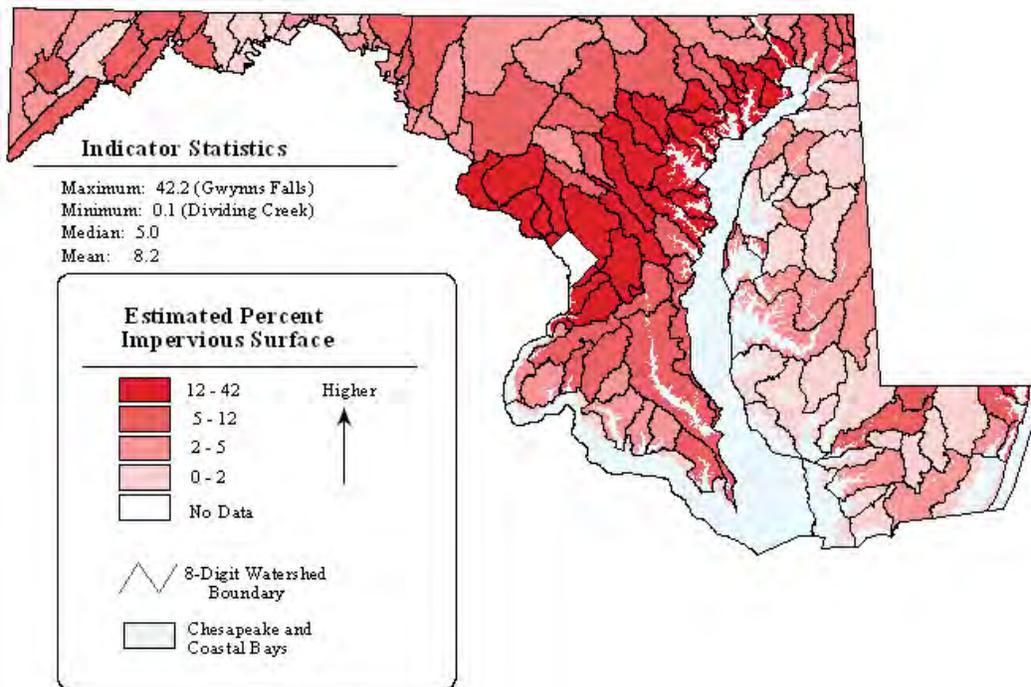
When development displaces a poorly managed farm, the impact on water quality is less obvious. Many farming operations in Maryland are highly polluting. However, it is easier to improve farming practices on an operating farm than to eliminate the harmful impacts of development. Limiting residential encroachment into farmland is therefore important for the future of water quality in the Chesapeake Bay watershed.

Water Shortages

When rain and melting snow rush directly into the Chesapeake Bay without filtration, not only does water quality in the bay suffer but drinking water supplies are also not replenished. In addition, sprawling growth increases water consumption. Together, these factors deplete water supplies.

Water consumption in low-density

Figure 1. Impervious Surfaces Exacerbate Runoff into the Chesapeake Bay¹¹



development is higher than in more compact areas. Lawns are often larger, requiring more water. A high percentage of residents rely on groundwater, rather than water from rivers or reservoirs, for their water supply. In Calvert County in southern Maryland, approximately half of homes rely on wells for drinking water, while in southern Anne Arundel County, groundwater is the only drinking water option.¹²

Water supplies are already clearly dropping in some areas of the state. The water level in the Magothy aquifer that serves southern Maryland has dropped by 90 feet beneath Charles County since 1975.¹³ Another aquifer, the Upper Patapsco, has dropped by 100 feet since 1969.¹⁴ In southern Anne Arundel County, maximum maintainable water withdrawal rates have already been reached.¹⁵

Water supply problems are more widespread in years of drought or low rainfall. Westminster, in Carroll County, established water use restrictions in the summer of 2007 because of inadequate water supply.¹⁶ The impact of low rainfall in 2006 and 2007 was made worse by rapid residential development that has driven up demand for water in Carroll County.¹⁷

When withdrawals from groundwater supplies outpace the rate at which rain and melting snow replenish aquifers, water quality can also suffer. That's already happening in some areas of the Eastern Shore. Water levels in the Aquia aquifer, which supplies water to Talbot and Queen Anne's counties, have been drawn down below water level in the Chesapeake Bay, resulting in brackish water entering parts of the aquifer.¹⁸ Saltwater intrusion into aquifers makes the water from those sources unsafe to drink.

The problems of insufficient quantity and impaired quality are projected to get worse as sprawling development continues. The Maryland Geological Survey estimates that by 2030, the aquifers beneath Charles County will not be able to supply

enough water to meet the needs of new homes.¹⁹ As more water is pumped from the aquifers beneath Charles County, water from the Potomac River may begin to seep in. Salt concentrations in the Potomac are high enough that its water is undrinkable, and its incorporation into groundwater could render the aquifers unusable.²⁰

Habitat Fragmentation

Low-density development, and the road network that supports it, breaks up forests, wetlands and meadows, with negative impacts on the number and diversity of plant and animal species. Approximately 60 percent of forestland in the Chesapeake Bay region is fragmented by development.²¹ Wetlands, too, are heavily disturbed by development.

Forest fragmentation greatly diminishes the amount of habitat available to birds such as the red-shouldered hawk and pileated woodpecker that prefer sheltered interior forest rather than more exposed habitat on the forest's edge.²² Predators present a larger threat at the edge, particularly for ground-nesting birds. Thus, the availability of preferred habitat has a large impact on breeding success.²³ Overall, individual bird species are more likely to disappear from areas with highly fragmented habitats.²⁴

For other animals, habitat fragmentation makes migration from one area to another more difficult. Regeneration of burned forest or damaged wetland occurs more slowly because plants cannot easily recolonize the area from undamaged areas.

In addition to fragmentation's impact on wetlands as habitat, when wetlands are broken into small, non-contiguous pieces, they are less able to help protect the quality of the Chesapeake Bay, provide flood control, and recharge groundwater supplies.²⁵

Loss of Scenic and Historic Areas

Sprawling development can turn a pastoral landscape into a denuded hillside covered with houses. Many Marylanders can name a favorite local viewpoint that has been altered due to sprawling development. Dispersed development threatens some of Maryland's outstanding scenic and historic sites. The cumulative impact of low-density development on the state's landscape is even more troubling.

Maryland has designated nearly 2,500 miles of roadway as "scenic byways," notable for their picturesque qualities.²⁶ These routes highlight the state's natural beauty and attract tourists. But in response to the aesthetic impacts of sprawl, the Maryland State Highway Administration has removed its scenic byway designation from 250 miles of road.²⁷

Sprawl also threatens some of Maryland's Civil War battlefields. The Civil War Preservation Trust has declared the South Mountain battlefield near Boonsboro one of the top 25 most endangered Civil War battlefields because of sprawl.²⁸

Long Commutes and Reduced Quality of Life

Spread-out residential subdivisions force residents to drive everywhere—to take the kids to school, to buy ingredients for dinner, or to get to work—rather than walking or using transit for some trips. Thus, low-density development is one of the factors that results in the long commutes that reduce residents' quality of life.

The number of vehicle-miles traveled (VMT) on Maryland roadways increased an average of 2.3 percent per year from 1990 to 2005.²⁹ While a growing population explains some of the increase in VMT, miles driven rose faster than population

growth. From 1990 to 2005, Maryland's population increased at an average rate of just over 1 percent per year.³⁰ Future VMT growth is expected to be slower, at 1.7 percent annually, but that still adds up to a total increase of 29 percent by 2020.³¹

Marylanders spend an average of 31.1 minutes commuting to work each day, ranking the state second only to New York for longest average commute times.³² Residents of Calvert, Charles and Prince George's counties spend the most time commuting. About 3.8 percent of Maryland residents and more than 8 percent of residents of Calvert and St. Mary's counties have commutes of 90 minutes or more.³³

Such lengthy commutes reduce the time that Marylanders can spend with family or in leisure activities. In fact, Maryland workers spend an average of 124 hours commuting each year, equal to three weeks of work.³⁴ That's more time than most employees are given annually for vacation.

Global Warming Pollution

By giving residents few real alternatives to driving, sprawling development contributes to Maryland's global warming pollution.

Transportation accounted for 30 percent of Maryland's global warming emissions in 2005 and was the state's second largest source of emissions.³⁵ Within the transportation sector, cars and light trucks accounted for 69 percent of emissions.³⁶ Emissions from transportation increased by 34 percent from 1990 to 2005 due to increased vehicle travel and the use of less efficient vehicles, and accounted for 49 percent of Maryland's total emissions growth in that period.³⁷

Assuming that the state's sprawling development patterns continue and that Marylanders continue to drive ever more miles each year, global warming pollution from transportation will continue to rise.

Total transportation sector emissions are projected to rise 26 percent from 2005 to 2020.³⁸

The state has much to lose from global warming. A combination of rising sea level and sinking land has resulted in a one-foot increase in relative sea level in Maryland in the past 100 years. In the next 100 years, a relative increase in sea level of 3 feet is likely, and much more is possible, potentially flooding 200 square miles of land and wiping out most of Maryland's tidal wetlands.³⁹ Storm surges from hurricanes could be worse. Heat waves could become more common, with temperatures above 100 degrees occurring on more than 24 days per year, increasing deaths from heat exposure.⁴⁰ The state's forest habitat could change, with pine trees becoming more

common as deciduous trees no longer thrive in the state. Changing temperatures and habitats could force as many as 34 species of birds, including the Baltimore oriole, to leave the state.⁴¹

More sensible development patterns—such as the creation of compact, walkable communities with access to public transit—can reduce all of these impacts of sprawl, preserving land for agriculture and wildlife, reducing the threat to the bay, and curbing oil consumption, global warming pollution, and the ever-growing length of Marylanders' commutes. It was this vision of “smart growth” that motivated the passage of Maryland's pioneering and innovative land-use laws in the 1990s. But, as will be described in the next section, it is a vision that has not yet become a reality.

Development Continues to Consume Vast Amounts of Land in Maryland

Marylanders know too well what “sprawl” looks like: the strip malls and big box stores with acres of parking, the tracts of homes on large lots with driveways but no sidewalks, the farms and forests being plowed under for new development.

Formally, sprawl can be defined as land-intensive, poorly planned development, which often requires extensive use of automobiles to get around. There are many objective criteria one might use to judge whether Maryland has made progress in its efforts to limit sprawl. The amount of land consumed for new development per resident is one useful indicator, since some amount of development is required to accommodate population growth. Tracking the rate of land development per new resident over time can provide a sense of how Maryland is faring in its efforts to contain sprawl.

Land Consumption Continues at a Rapid Pace

Commercial and residential development have spread rapidly across the Maryland

landscape over the last several decades. Between 1973 and 2002, the amount of land devoted to residential, commercial and industrial uses in the state doubled, resulting in the loss of 650,000 acres of farms and forests to development.⁴²

About 176,000 acres have been converted to residential or commercial development since the beginning of 1998, the year after the enactment of Maryland’s smart growth laws. (Implementation of those laws—particularly the designation of priority funding areas, or PFAs—began in 1998 but extended well into 1999.) In other words, since the beginning of 1998, Maryland has converted about 3 percent of its total land area to new residential and commercial development.

About two-thirds of the land that has been developed since the beginning of 1998 has been in 10 Maryland counties, with nine of those counties within the U.S. Census Bureau’s formal boundaries of the Washington or Baltimore metropolitan areas. St. Mary’s County, which is quickly becoming a Washington suburb although it is not within the Census Bureau’s definition of the metro area, is particularly striking. Although St. Mary’s County ranked 12th

Understanding the Numbers in this Report

In this section of the report, we discuss the trends in residential and commercial development in Maryland. It is important, particularly when comparing the figures in this report to other published estimates of development trends, to understand what is and is not included in the estimates that follow.

First, the figures for “developed land” in this report are based on the size of the parcels of land developed and not the “footprint” of buildings and other structures on the land.

Second, the figures in this report do not include development in Baltimore City. Having reached build-out long ago, an analysis of lost open space cannot be applied in Baltimore equally with the rest of the state.

Finally, we exclude residential development on very large parcels (20 acres or more), in part because development is likely to only occupy a small portion of the lot, and in part to be consistent with the methods used by the Maryland Department of Planning.

in terms of total population growth since 1998, it has experienced the second-greatest amount of land conversion to residential and commercial development. Indeed,

Montgomery County accommodated five times as many new residents as St. Mary’s on approximately the same amount of newly developed land.

Table 1. Acres of New Residential/Commercial Development Since Beginning of 1998 (top 10 counties)

County	Total acres developed	Pct. of land area developed
Baltimore County	13,456	3.5%
St. Mary’s	12,886	5.4%
Charles	12,766	4.4%
Prince George’s	12,444	4.0%
Harford	11,609	4.1%
Anne Arundel	11,449	4.3%
Montgomery	11,338	3.6%
Frederick	11,188	2.6%
Howard	11,067	6.9%
Carroll	10,724	3.7%

Several Maryland counties have converted a significant share of their land area to development over just the last decade. Commercial and residential development claimed nearly 7 percent of the land area of Howard County and more than 5 percent of the land area of Calvert and St. Mary’s counties since the beginning of 1998. As noted above, not every square inch of these properties has been paved over—in some cases, commercial or residential building owners may have left some part of the “developed” property in its natural (though possibly now fragmented) state. But the continued loss of land to residential and commercial development—even after several decades of sprawl in many Maryland counties—is breathtaking.

Development Is Consuming Significant Amounts of Land per Person

Among the goals of smart growth policy in Maryland was to make new development in the state less sprawling—that is, to be more efficient in the use of land to accommodate new residents.

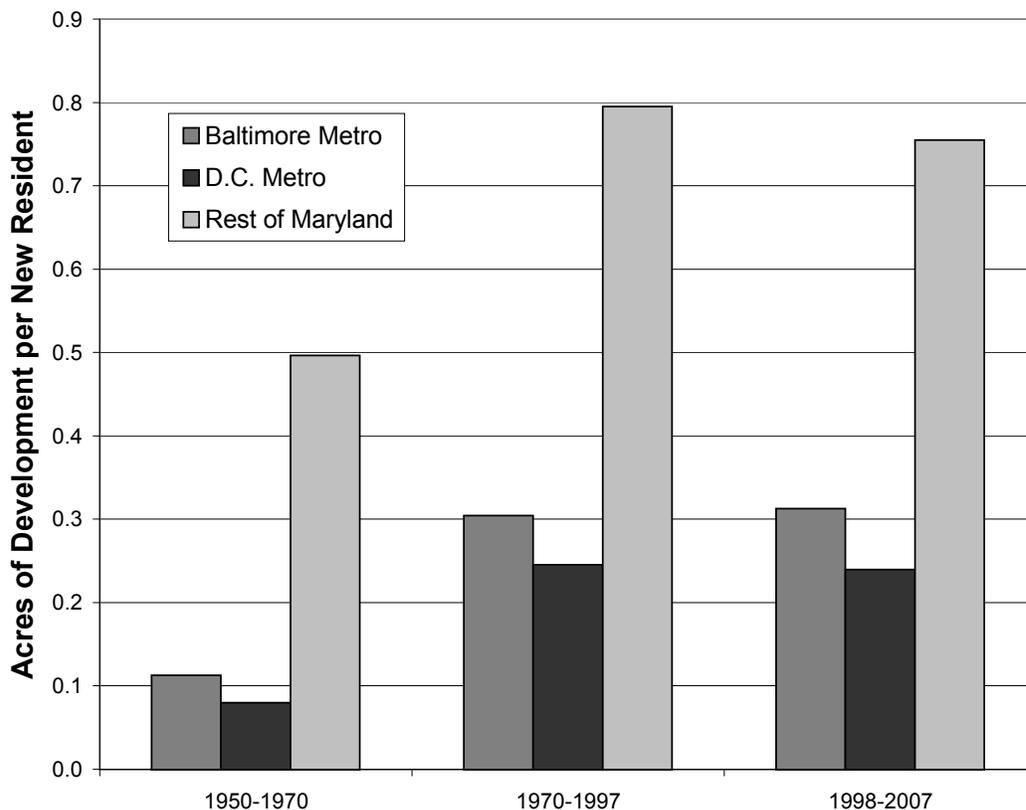
Unfortunately, since the beginning of 1998, development in Maryland has consumed approximately the same amount of land per person as it did during the period from 1970 to 1997. Between 1998 and 2007, new residential and commercial development (outside of Baltimore City) consumed approximately 0.35 acres per new resident, compared to 0.34 acres per new resident between 1970 and 1997. This compares to 0.12 acres per resident for development that took place between 1950 and 1970, meaning that new development in Maryland

Montgomery County accommodated five times as many new residents as St. Mary's County on approximately the same amount of newly developed land.

currently consumes about three times as much land per new resident as development that took place between 1950 and 1970.

As would be expected, the amount of land developed per person tends to be lower in more urbanized counties and higher in more rural areas of the state. Since the beginning of 1998, for example, new commercial and residential development in the Baltimore metropolitan area consumed about one-third of an acre per person, compared to approximately one-quarter of an acre per person in the Washington, D.C.,

Figure 2. Land Consumption per New Resident



area, and approximately three-quarters of an acre per person in counties that are not a part of either metropolitan area.⁴³

Maryland's Washington, D.C., suburban counties have historically been slightly more efficient in the use of land to accommodate new population than the suburbs of Baltimore. In both areas, however, land consumption rates have remained about the same since the passage of Maryland's smart growth laws in 1997.

Land Consumption per Capita: Baltimore Metropolitan Area

The Baltimore metropolitan area consists of five counties—Anne Arundel, Baltimore, Carroll, Harford and Howard—along with Baltimore City, which is excluded from this analysis. (A sixth county, Queen Anne's, is formally part of the Baltimore metropolitan area, but is classified with the remainder of the Eastern Shore here.) Since the beginning of 1998, development

Figure 3, a-f. Block Groups in Which More than 10 Percent of Land Area Was Developed, by Decade, State

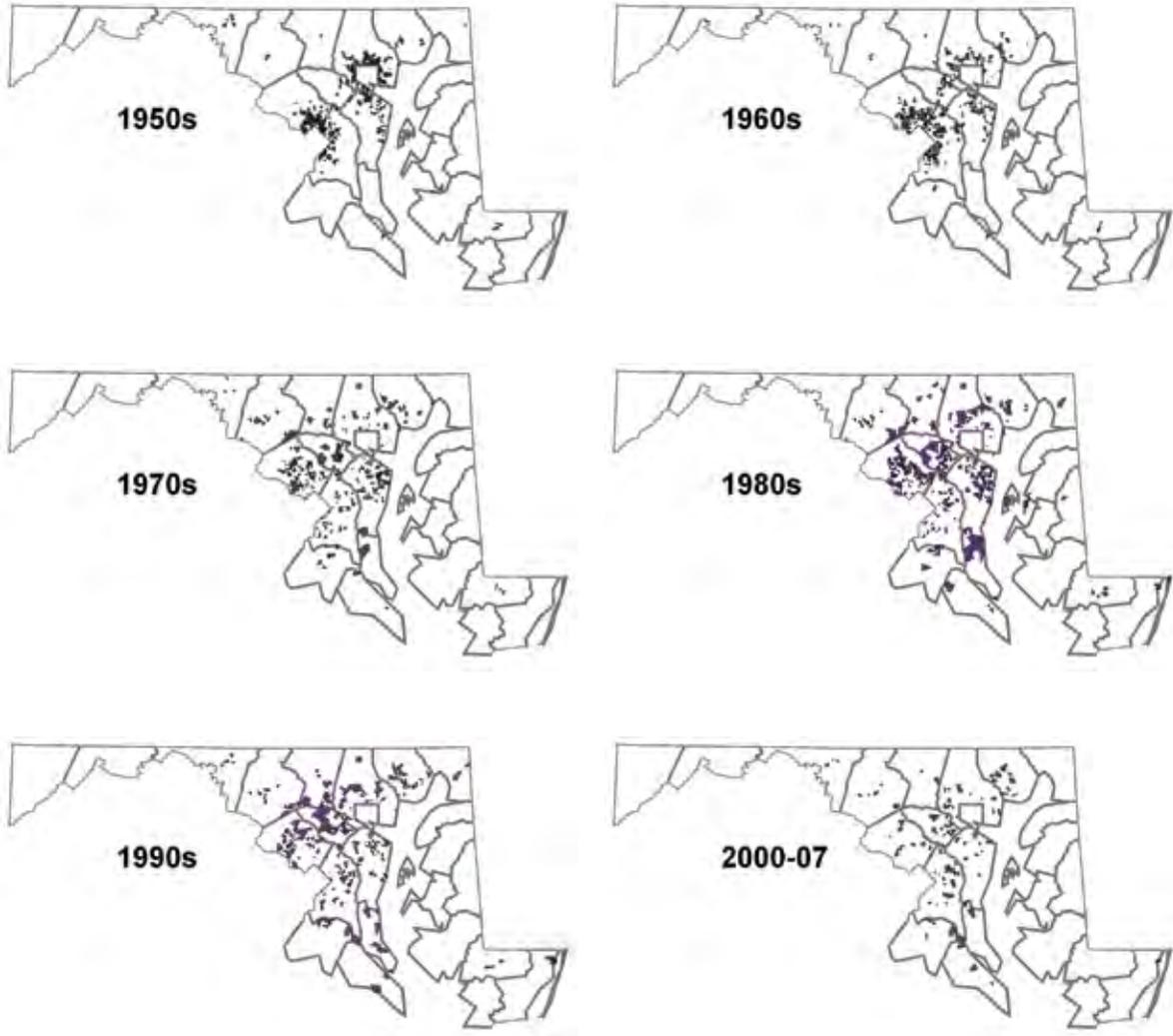


Figure 4, a-f. Block Groups in Which More than 10 Percent of Land Area Was Developed, By Decade, Baltimore/DC Area (Lighter Shaded Areas Indicate Areas of Intense Development in Previous Decade for Comparison)



has consumed the least amount of land per person in Howard County, at approximately one-quarter of an acre per new resident, and consumed the most land per new resident in Carroll County. Several counties, including Baltimore, Carroll and Howard, have reduced their level of land consumption per new resident since the beginning of 1998.

On the other hand, Anne Arundel and Harford counties experienced significant increases in land consumption per capita. Anne Arundel County experienced a 41 percent increase in land consumption per new resident since 1998 (compared with the period between 1970 and 1997) and Harford County experienced a 27 percent increase.

Table 2. Acres per New Resident of Commercial and Residential Development, Baltimore Suburban Counties

County	1950-1969	1970-1997	1998-2007
Anne Arundel	0.10	0.20	0.29
Baltimore Co.	0.08	0.36	0.28
Carroll	0.29	0.50	0.43
Harford	0.19	0.32	0.41
Howard	0.20	0.27	0.24

Land Consumption per Capita: Washington, D.C., Metro Area

Three of the five D.C.-area counties—Calvert, Frederick and Montgomery—have used less land per capita for residential and commercial development since 1998 compared with the period between 1970 and 1997. In Charles County, however, development consumed significantly more land per person than in previous years. (See Table 3.)

Montgomery County, in which new commercial and residential development consumed just 0.12 acres per person between 1998 and 2007, experienced the

lowest rate of per capita development in the state over this time period. Indeed, if all of Maryland had achieved a similar rate of land consumption as Montgomery County, the state could have protected 116,000 acres from development between 1998 and 2007.

Table 3. Land Consumption per New Resident, D.C. Suburban Counties

County	1950-1969	1970-1997	1998-2007
Calvert	0.34	0.52	0.39
Charles	0.32	0.41	0.47
Frederick	0.31	0.35	0.27
Montgomery	0.07	0.14	0.12
Prince George's	0.06	0.24	0.26

Land Consumption per Capita: The Rest of Maryland

The remainder of Maryland can be broken down into three categories. The first category includes two counties that are not formally part of a Maryland metropolitan area, but which are influenced by sprawl: Cecil and St. Mary's counties. Cecil County, which is officially part of the Wilmington, Del., metropolitan area, has grown more land-efficient for new development since 1998. St. Mary's County, however, consumed slightly more land per resident—a significant problem given that the county has experienced the second-highest amount of land consumption for residential or commercial uses since 1998, trailing only Baltimore County.

In the remainder of Maryland, which is mainly rural, land consumption per person is significantly higher than in the suburban areas. In two of western Maryland's three counties—Allegany and Garrett—population has declined in recent years, although land has continued to be developed for residential and commercial use.

Table 4. Land Consumption per New Resident, Rest of Maryland (Acres per Capita)

County	1950-1969	1970-1997	1998-2007
Exurban Maryland			
Cecil Co.	0.23	0.64	0.39
St. Mary's Co.	0.31	0.69	0.75
Western Maryland			
Allegany Co.	NA	NA	NA
Garrett Co.	16.06	1.61	NA
Washington Co.	0.25	0.70	0.56
Eastern Shore			
Caroline Co.	1.48	0.90	1.00
Dorchester Co.	1.37	4.21	2.73
Kent Co.	0.67	1.39	1.55
Queen Anne's Co.	0.52	0.55	0.42
St. Mary's Co.	0.31	0.69	0.75
Somerset Co.	NA	0.86	1.62
Talbot Co.	0.69	1.14	1.27
Wicomico Co.	0.27	0.46	0.42
Worcester Co.	1.41	0.42	0.70
NA = Population decreased in this county during this time period.			

It is important to note that land consumption per capita is just one indicator of sprawl. It is possible for an area with relatively small per-capita land consumption to exhibit other characteristics of sprawl—for example, poorly planned development or community design that requires the use of the automobile to complete daily tasks.

It is also important to note that several Maryland counties have significantly reduced the amount of land consumed per new resident since 1998, compared with the period between 1970 and 1997. Cecil County reduced the amount of land consumed for residential and commercial development per new resident by 39 percent compared with the 1970-97 period. Calvert, Frederick, Baltimore, Montgomery and Carroll counties each experienced reductions of 10 percent or more in land consumption per new resident.

Development Continues to Push into Formerly Rural Areas of Maryland

Throughout Maryland, “new ground” is continually broken to accommodate growth, with formerly rural areas of the state converted into suburbs and exurbs. While suburban development has been going on in Maryland for more than a century, it has only been within the last 40 years that broad swaths of the state have been converted to low-density development.

To depict the geographic spread of development in Maryland, we used GIS software to evaluate development trends in U.S. Census “block groups” across the state. (A “block group” is a subset of a Census tract. Block groups have populations ranging from a few residents in some rural areas to several thousand residents in urban and suburban areas. There are more than 3,600 Census block groups in Maryland.)

The two sets of maps on pages 14 and 15—Figure 3, a-f, and Figure 4, a-f—illustrate the spread of residential and commercial development in Maryland by decade since the 1950s. The highlighted block groups in each map indicate those areas where more than 10 percent of land was converted to commercial or residential development during that decade. As the maps indicate, the areas of Maryland that were most intensely developed during the 1950s and 1960s were generally those immediately adjacent to Baltimore, Annapolis and Washington, D.C.

By the 1970s and 1980s, development was increasingly filling in the Baltimore-Washington corridor, while spreading to areas further from the metropolitan core, including areas such as Frederick, Carroll, Calvert and Charles counties, which had seen little intense suburban development up until that time. By the 1990s and 2000s, the most intensive areas of development were in places even further dispersed across

the state. Figure 5 shows those areas that have been most intensely developed since the beginning of 1998.

Residential Development Is Driving Increased Land Consumption

Of the two types of development considered here—residential and commercial—new housing has played a far more significant role in accelerating the pace of land consumption in Maryland.

In the last section, we compared development to population growth by county. In this section, we look at growth per unit of new housing.

Figure 6. Average Size of a Newly Developed Residential Parcel Since Beginning of 1998

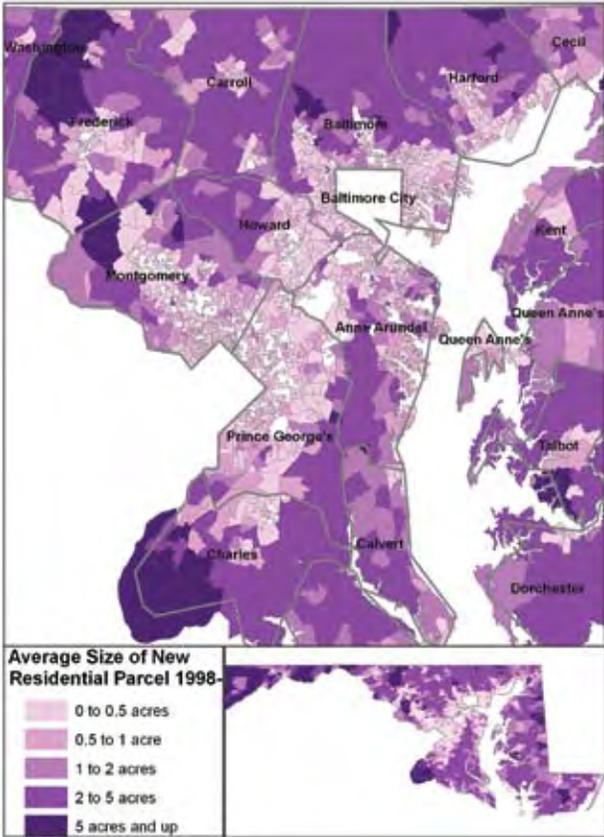
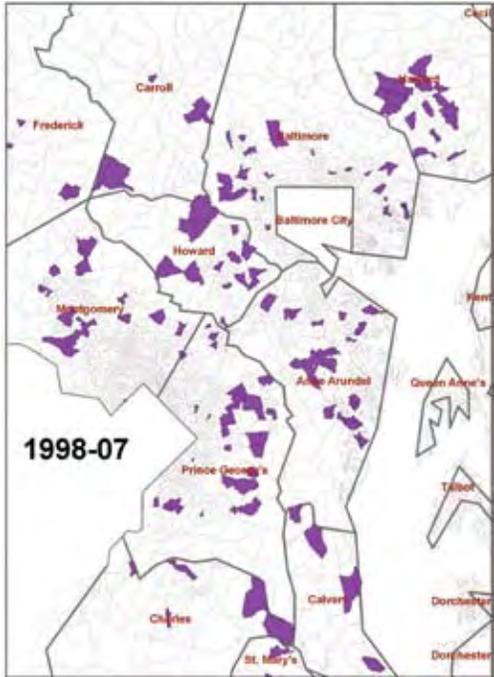


Figure 5. Block Groups in Which More than 10 Percent of Land Area Was Developed, 1998-2007, Baltimore/DC Area



There is great variation among Maryland counties in the amount of land consumed per unit of residential development. State-wide, the average new home built between 1998 and 2007 was located on a parcel 0.95 acres in size. (This figure excludes apartments and condominiums, and also some single-family homes built on very large lots of 20 acres or more.) A few counties—including Montgomery, Prince George's and Anne Arundel—used considerably less land per new home than the state average. But several other fast-growing counties—including Calvert, Charles and St. Mary's counties—used an acre or more of land for each new home.

Figure 6 shows land consumption per new home by Census block group. The map demonstrates that land consumption per new home remains at 0.5 acres or less in most of the Baltimore-Washington corridor, the immediate Baltimore and

Washington suburbs, and even in some rapidly growing areas in Prince George’s, Montgomery, Frederick, Harford and Howard counties. But in more distant areas, including fast-growing parts of Calvert, Charles and St. Mary’s counties, residential development consumes vast amounts of land.

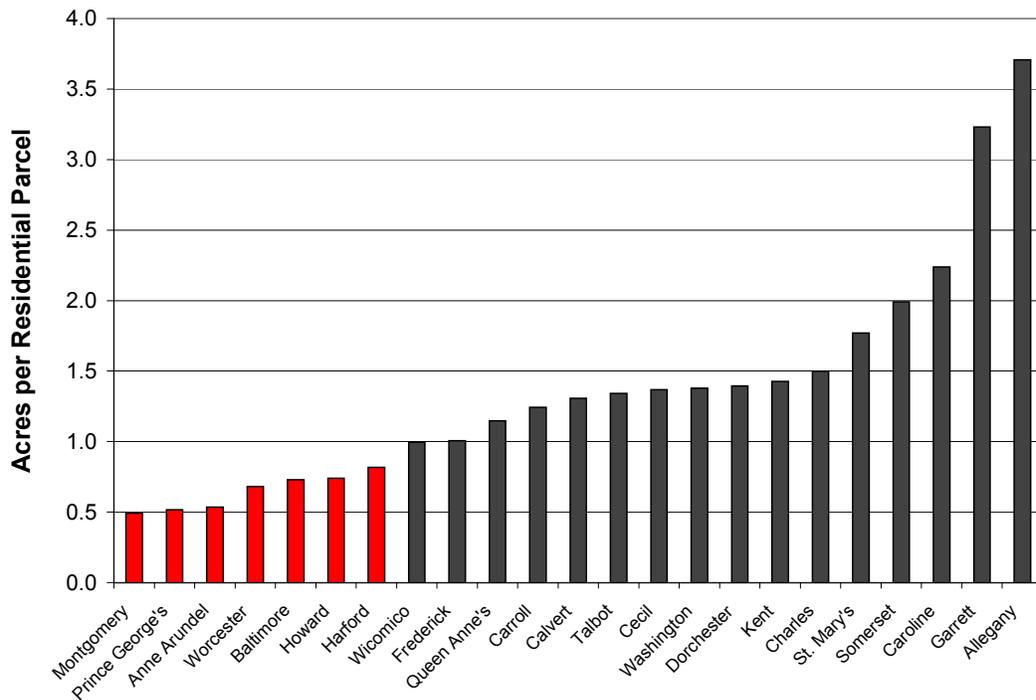
Development Outside Priority Funding Areas Consumes Large Amounts of Land

Among the smart growth policies adopted by Maryland in the late 1990s, the centerpiece was undoubtedly the Smart Growth Areas Act. The law created a process for

the designation of Priority Funding Areas (PFAs)—areas where future growth was to be encouraged. The law called for the state to direct “growth-related” funds toward PFAs. Implicit in the law was the idea that by directing state resources toward PFAs, Maryland could ease development pressure in more rural areas of the state.

Maryland law gives counties and municipalities the power to define PFAs. The state of Maryland cannot override those decisions, but the Maryland Department of Planning does identify portions of locally designated PFAs that do not appear to be consistent with the criteria laid out in state law. These areas are called “comment areas.” State funding for growth-related projects within comment areas requires special approval. In order to highlight

Figure 7. Acres per New Residential Parcel Since Beginning of 1998 (Shaded Counties Are Below State Average)



growth trends in areas meeting the definition of PFAs under state law, we focus on development in “approved PFAs”—locally designated PFAs minus comment areas.

An analysis of residential development (not including apartments and condominiums) in Maryland since the beginning of 1998 sheds light on both the promise and the weaknesses of Maryland’s smart growth efforts.

Residential Development Within PFAs Consumes Less Land Per Unit of Housing

New residential development taking place within PFAs consumes much less land than development taking place outside of PFAs. Again excluding Baltimore City, new residential parcels developed inside

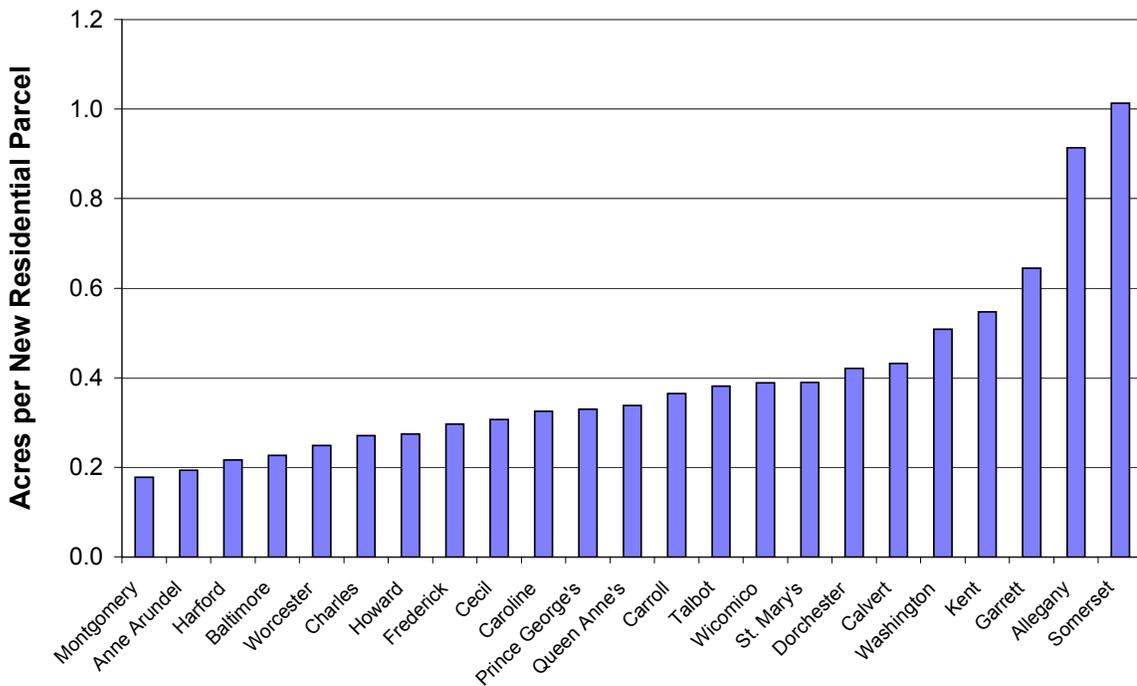
approved PFAs occupied an average of 0.3 acres, compared to 2.1 acres for new homes built outside PFAs. (Residential parcels developed in PFA comment areas averaged approximately 0.6 acres.)

Residential development within approved PFAs used less land per parcel than the statewide average for all residential development in every Maryland county except one (Somerset). (See Figure 8.)

Most New Housing Was Built Within PFAs ...

About 66 percent of new residential parcels were developed inside approved PFAs after the beginning of 1998. However, there was tremendous variation among Maryland counties in the share of new residential

Figure 8. Average Size of Residential Parcels Inside Approved PFAs



development taking place within PFAs. In four Maryland counties—Montgomery, Prince George’s, Baltimore and Harford—more than three-quarters of all new residential parcels were developed within approved PFAs. Note that this figure does not include apartments and condominiums built in these areas. Other counties, however, have not fared nearly as well. In nine Maryland counties—including fast-growing Calvert and St. Mary’s counties—more than half of new residential parcels were developed outside approved PFAs.

... But More Land Was Consumed for Development Outside of PFAs

Because each home built outside a PFA sits on a parcel that is, on average, seven times larger than a home built within an approved PFA, even a small number of houses built outside of PFAs can result in large amounts of land being converted to development.

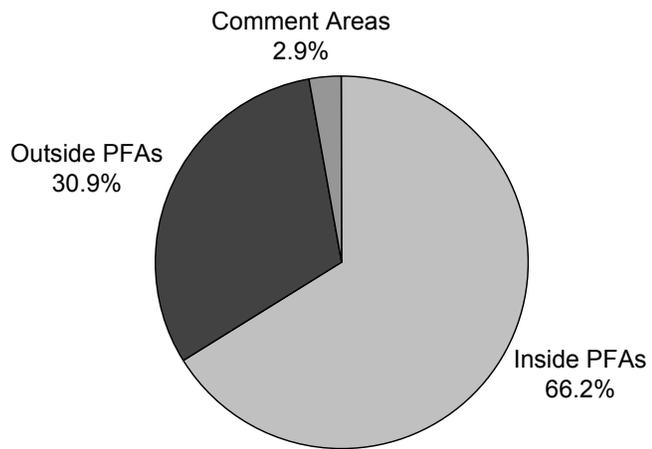
Figure 9, a-b. Residential Development Inside and Outside of PFAs

Table 5. Percentage of Residential Parcels Developed Outside Approved PFAs Since 1998

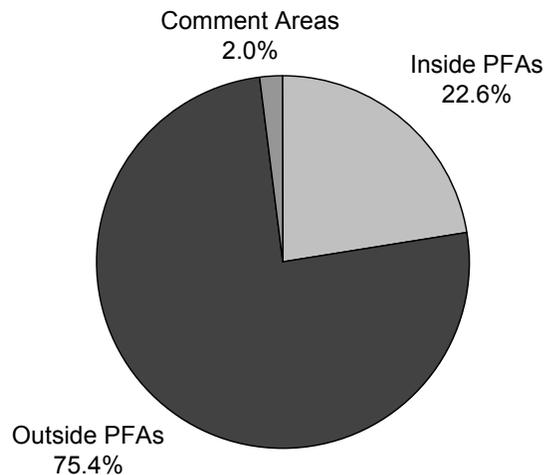
Montgomery	19.7%
Prince George’s	20.9%
Baltimore County	21.7%
Harford	22.4%
Howard	25.7%
Worcester	28.3%
Anne Arundel	29.1%
Talbot	30.0%
Frederick	36.4%
Allegany	37.2%
Carroll	39.2%
Somerset	43.2%
Kent	45.6%
Charles	48.4%
Queen Anne’s	52.2%
Washington	53.7%
Dorchester	56.2%
St. Mary’s	60.0%
Cecil	60.7%
Calvert	64.0%
Caroline	66.1%
Wicomico	66.6%
Garrett	87.3%

All in all, more than 64,000 homes were built outside approved PFAs between the beginning of 1998 and 2007.

Number of New Residential Parcels



Acres of New Residential Parcels



Indeed, while only 34 percent of the residential parcels developed between 1998 and 2007 were outside approved PFAs, development outside of approved PFAs accounted for 77 percent of the land converted to residential development over that time period. (See Figure 9, a-b, previous page.)

In only one county—Prince George’s—did the number of acres devoted to new residential development within approved PFAs exceed the amount developed outside of approved PFAs. In 15 Maryland counties, more than three-quarters of new acreage devoted to residential development was outside of approved PFAs. (See Figure 10.)

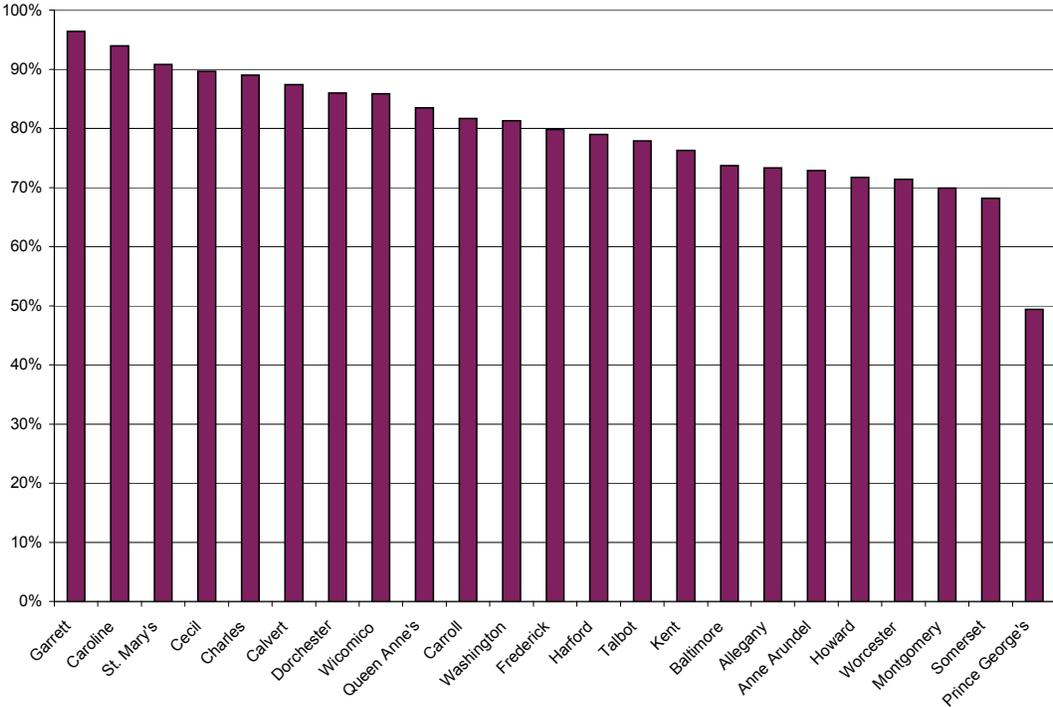
What is the impact of residential development outside of planned growth areas? Consider the following: if all the residential development that took place in

Maryland’s counties used the same amount of land as residential development within those counties’ PFAs, Maryland could have protected more than 100,000 acres from development between 1998 and 2007—an area roughly twice the size of Baltimore City. (See Table 6.)

Conclusion

The stakes involved in Maryland’s smart growth efforts are great. The Task Force on the Future of Growth and Development in Maryland projects that, with current policies, Maryland could see an additional 650,000 acres converted from rural to urban uses by 2030. According to the task force, “[f]orests and farms would be replaced by houses and highways stretching from the head of the Chesapeake Bay to Southern Maryland.”⁴⁴

Figure 10. Percentage of New Residential Acres Developed Outside Approved PFAs: 1998 to 2007



If all the residential development that took place in Maryland’s counties used the same amount of land as residential development within those counties’ PFAs, Maryland could have protected more than 100,000 acres from development between 1998 and 2007—an area roughly twice the size of Baltimore City.

However, the task force also found that if 80 percent of future development could be focused within PFAs at a rate of four residential units per acre, Maryland could preserve 500,000 of the 650,000 acres that would otherwise be developed.

As the data presented here show, Maryland continues to lose vast amounts of land to sprawling residential and commercial development. However, some Maryland counties are beginning to make strides toward promoting focused, compact and smart forms of development.

By augmenting Maryland’s existing smart growth laws and improving enforcement, Maryland can curtail the sprawling development that is harming our environment and eroding our quality of life.

Moreover, we can build vibrant communities that can be sustained for the long

haul. We have already overbuilt low-density suburban development; now we need to provide better options for people who want to live in modern, mixed-use communities. Maryland could potentially put nearly all new development close to existing and planned transit stations and next to existing rural towns. By focusing almost exclusively on transit-oriented development and rural villages, planners/developers would bring exciting new housing choices in Maryland, while helping to reduce future sprawl.

Table 6. Acres of Land That Could Have Been Left Undeveloped if All Residential Development Was of the Same Parcel Size as Development within Approved PFAs, 1998-2007

Allegany	1,255
Anne Arundel	6,198
Baltimore County	7,840
Calvert	4,811
Caroline	2,682
Carroll	7,234
Cecil	5,137
Charles	9,642
Dorchester	1,819
Frederick	6,731
Garrett	3,866
Harford	7,961
Howard	4,858
Kent	837
Montgomery	6,435
Prince George’s	3,940
Queen Anne’s	2,101
St. Mary’s	9,467
Somerset	881
Talbot	2,701
Washington	4,588
Wicomico	2,412
Worcester	2,158

Smart Growth Policy in Maryland: What Has Gone Wrong and How Can We Fix It?

Despite the enactment of innovative smart growth laws in the late 1990s, sprawling development has continued in much of Maryland over the last decade. Maryland cannot afford another decade of unchecked sprawling development that consumes vast amounts of farmland and forests, creates air and water pollution, and erodes our quality of life.

There is an alternative: Maryland can rebuild our existing communities and, where we do build on new land, encourage the development of compact, walkable communities with access to transportation alternatives such as public transit—the kinds of communities that are becoming increasingly popular across the country. At the same time, the state can work to preserve its existing farmland and forests and ensure that any future development protects the health of the Chesapeake Bay.

Achieving this vision of “smart growth,” however, is going to require new policy tools. Even more than that, however, it is going to require the political will to actually enforce those policies.

There are several important steps Maryland could take to put real teeth into its smart growth policies and reduce the

rampant, sprawling development that puts our environment, quality of life, and long-term economic viability at risk.

Make county comprehensive plans enforceable. For the last decade, Maryland has, in effect, had two sets of land-use policies. There is the thoughtful, smart growth-oriented vision embodied in Maryland’s smart growth laws and many county comprehensive plans developed with extensive public involvement. And then there is land-use policy as it is actually implemented through county and municipal zoning ordinances and the *ad hoc* exceptions made to those laws at the local level.

The disconnect between these two sets of policies is demonstrated most dramatically in the case of the proposed Terrapin Run development in Allegany County. A developer, PDC, Inc., proposed building a 4,300-unit, 935-acre development in the midst of a rural, mountainous area of the county. The development clearly contradicted the county’s adopted comprehensive plan, which called for the area to be protected from large-scale development. Yet, the Allegany County Board of Zoning Appeals approved a special exception to

the county zoning ordinance to allow the development to move forward. In a blow to smart growth advocates, the Maryland Court of Appeals ruled that the board was within its rights to issue the exception. The result of the decision is that citizens now have little legal recourse to ensure that the comprehensive planning process actually results in good land-use decisions on the ground.

The state of Maryland should clarify that county comprehensive plans are written to be implemented, and require that zoning ordinances and other actions be aligned with the plan. In addition, Maryland should set a universal timeline for implementation of comprehensive plans, and limit the availability of exceptions for development that contradict the comprehensive plan.

In addition to making comprehensive plans enforceable, the state should require those plans to include detailed provisions for how each county plans to accommodate future residential growth—including a wide range of housing opportunities, some of them affordable to people earning 50 percent or less of the area’s median income—so that a lack of infrastructure in one municipality or county does not force housing development to “leapfrog” into areas even further away from urban centers.

Develop and implement coordinated standards for growth. In 1992, the Maryland General Assembly adopted a set of eight “visions” for smarter growth. While the visions remain an important step forward, by almost every measure

they have not slowed the march of sprawl development into Maryland’s countryside. Better-defined and better-coordinated benchmarks are needed to move Maryland toward the future envisioned by the Legislature in 1992 and widely supported today.

The time has come for Maryland to adopt statewide standards for growth management that will enable Marylanders to evaluate whether Maryland’s visions will be met. Local comprehensive plans must be designed to achieve these goals. Additionally, the actions of state agencies—including funding decisions—should support plans that will meet Maryland’s goals for smarter growth.

Put teeth into smart growth policies. Perhaps the most innovative element of Maryland’s 1997 smart growth laws was the decision to use state government’s “power of the purse” to encourage better development and land-use decisions by county government. The Smart Growth Areas Act committed the state to use its resources to support responsible growth within PFAs, but it also threatened to withhold state funding for projects that support growth outside PFAs.

It is clear that sprawl development outside of PFAs is undermining Maryland’s investment in smart growth. Maryland must ensure that any rewrite of the state’s smart growth laws directs investment to communities that plan for responsible development and withholds state funds from projects and development plans that contradict state goals.

Methodology

Cautions and Caveats

Readers should keep in mind a few cautions and caveats as they interpret the data in this report.

First, this analysis reviews trends in residential and commercial development in Maryland—the types of development most associated with sprawl. We specifically excluded land devoted to industrial and agricultural uses. We also excluded land classified as tax-exempt (usually public facilities such as schools and libraries, as well as churches and other institutions that do not pay taxes, such as federal government facilities) and some land-intensive “commercial” uses such as burial grounds, golf courses and other recreational facilities.

Second, the measuring stick we use in quantifying land consumption is the size of the parcel of land on which a new residential or commercial structure was built. In most cases, this measure provides a good proxy for the amount of land used for development. In some cases, however—such as a small home built on a large lot—some of the land classified here as “developed” in this analysis may actually have been left in

its natural state. To minimize this effect, we eliminated all residential parcels of 20 acres or more from the analysis.

Third, the data source we used for these calculations—the MD Property View database compiled by the Maryland Department of Planning—has several important limitations. Residential and commercial condominiums, for example, are often labeled as taking up no land, when of course they do take up a small amount of land.

Lastly, the date on which development took place was assumed to be the year in which the structure that currently occupies the site was built. In some cases, the current structure might not have been the first one to occupy the property—for example, a strip mall built in the 1990s on the site of a former car dealership built in the 1950s would be classified as having been “developed” in the 1990s, even though the property was in commercial use long before that. However, while large redevelopment projects tend to be high-profile, they are small in number.

The detailed methodological description that follows provides more information on how this analysis was conducted.

Data Sources

Population and Geography

Population data by county were obtained from the U.S. Census Bureau. Population data came from the following sources: (1950) U.S. Census Bureau, *1990 Census of Population and Housing: Population and Housing Unit Counts: United States*, undated; (1970) U.S. Census Bureau, *Estimates of the Intercensal Population of Counties, 1970-1979*, April 1982; (1980) U.S. Census Bureau, *Intercensal Estimates of the Resident Population of States and Counties, 1980-1989*, March 1992; (1990-1999) U.S. Census Bureau, *Time Series of Maryland Intercensal Population Estimates by County: April 1, 1990 to April 1, 2000*, 17 April 2002; (2000-2007) U.S. Census Bureau, *Annual Estimates of the Population for Counties of Maryland: April 1, 2000 to July 1, 2007*, 20 March 2008.

Geographic information, including the land area of Census block groups, was based on data included in ArcMap 9.2.

Development

All data on development were derived from the MD Property View data set compiled by the Maryland Department of Planning (MDP). The 2007 version of MD Property View was supplied by MDP for all counties except Anne Arundel, Montgomery and Wicomico, for which the 2006 version was used. To conduct the analysis, we exported from MD Property View the county parcel database, which includes details on the structures built on each parcel in each county, as well as the size of the parcels and their land-use category.

Parcels were excluded from this analysis for several reasons:

- 1) *Potential errors and skewing of the data*—All parcels of 500 acres or more were excluded for two reasons. First, several parcels were listed as being 500 acres or more in error. A manual comparison of the parcel database with the tax

maps included in MD PropertyView found that the size of several parcels was given in acres rather than square feet, potentially introducing a large error to the analysis. While the size of some 500+ acre parcels was listed accurately in the MD PropertyView database, it is likely that development consumes only a small portion of many of these parcels. As a result, all were excluded.

- 2) *Excluded land uses*—Among the land uses excluded from the analysis were the following: agricultural, country club, exempt, exempt commercial, industrial and marshland land-use classifications, as well as the following land uses identified in the MD Property View database as “commercial”: industry, recreation and boating-related parcels, burial-related/cemetery, transport related, telecom towers and other yard items, public property, operating and non-operating utility and railroad properties. These land uses were deemed to be either very land-intensive (with the corresponding potential to distort the results of the analysis) or to be only tangentially related to commercial and residential sprawl. In addition, we excluded all residential parcels of 20 acres or more.
- 3) *No structure, no date given for construction of the structure, or no land area given for the parcel*—Parcels on which no structure was listed as existing, or for which no size of structure was given, were excluded, as were parcels on which a structure does exist, but where no date was given for construction of that structure or no land area estimate was given for the size of the parcel. These conditions likely resulted in some legitimate residential and commercial developments being excluded from the analysis for lack

of adequate data. For example, many residential and commercial condominium units were listed as taking up no land. As a result, all estimates of residential development per unit exclude both condominiums and apartment buildings.

Data Analysis

Land consumption per new resident by county

The number of acres covered by non-excluded residential and commercial parcels in the MD PropertyView database was totaled based on the year the structure occupying each parcel was built. Parcels with structures built between 1950 and 1969 were included in the pre-1970 category, those built between 1970 and 1997 were included in a second category, and those built from 1998 until the end of the time period covered in each county's data set were included in a third category. The total number of acres developed for each county was then divided by the number of residents the county added during that time period to arrive at an estimate of the number of acres developed per new resident. Population data for 2007 were used for all counties in calculating the per-capita land development rate for the various counties, despite the varying end dates for data coverage among the counties in MD Property View.

Development by Census block group

Parcels that were converted to residential or commercial development were totaled

by the decade during which the structure occupying that parcel was built, from the 1950s to the present, based on their Census block group (as listed in the MD Property View database). These data were then joined to the base map layer in ArcMap 9.2. The land area data in ArcMap 9.2 were used to identify those parcels in which more than 10 percent of total land area was converted to development in each decade.

Residential development analysis

The land area of parcels in the residential land-use group was totaled for each county and divided by the number of parcel records for the relevant time period in MD Property View.

Inside/outside of Priority Funding Areas analysis

The PFAs designated in MD Property View were used to identify parcels inside and outside of PFAs and within PFA comment areas. The "select by attributes" function in ArcMap was used to identify which developed parcels were located inside and outside of PFAs or in comment areas. The analysis of land area consumed for development inside and outside of PFAs, along with the residential development analysis, were conducted as described above. Note: this analysis does not take into account changes in the boundaries of PFAs over time. In other words, some developed parcels listed as being within PFAs may not have been within the boundary of a PFA at the time development occurred.

Notes

1. Task Force on the Future of Growth and Development in Maryland, *Where Do We Grow from Here?*, 1 December 2008.
2. Woods Hole Research Center, *Resource Land Loss*, downloaded from www.whrc.org/midatlantic/eco_apps/resource_land_loss.htm, 15 December 2008.
3. Department of Natural Resources, *Maryland's Rural Legacy Program*, downloaded from www.dnr.state.md.us/land/rurallegacy/index.asp, 12 December 2008.
4. See note 2.
5. Chesapeake Bay Program, *Stormwater*, downloaded from www.chesapeakebay.net/stormwater.aspx?menuitem=19515, 15 December 2008.
6. Chesapeake Bay Program, *Development*, downloaded from www.chesapeakebay.net/developmentpressure.aspx?menuitem=19514, 15 December 2008.
7. Ibid.
8. Ibid.
9. Maryland Department of Natural Resources, *Percent Impervious Surfaces*, March 2000.
10. U.S. Geological Survey, *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystems and Implications for the Environmental Management, Chapter 2: Human Population Growth and Land-Use Change*, 2007.
11. See note 9.
12. Calvert: Jen Degregorio, "Southern MD Water Shortage Blamed on Flood of New Residents," *The Daily Record*, 9 December 2005; Anne Arundel: David Andreasen, Maryland Geological Survey, *Future of Water Supply from the Aquia and Magothy Aquifers, Southern Anne Arundel County, Maryland*, 2002.
13. Jen Degregorio, "Southern MD Water Shortage Blamed on Flood of New Residents," *The Daily Record*, 9 December 2005.
14. Ibid.
15. David Andreasen, Maryland Geological Survey, *Future of Water Supply from the Aquia and Magothy Aquifers, Southern Anne Arundel County, Maryland*, 2002.
16. Mike Silvestri, "Water Shortage Once Again Tops List of Carroll County Priorities," *The Baltimore Examiner*, 15 January 2008.
17. "Westminster's Water Woes" (editorial), *The Baltimore Sun*, 29 September 2006.
18. Maryland Geological Survey, *Hydrogeology of the Coastal Plain Aquifer System in Queen Anne's and Talbot Counties, Maryland, with a Discussion of Brackish-Water Intrusion in the Aquia Aquifer, Report of Investigations No. 72*, March 2005.
19. David Drummond, Maryland Geological Survey, *Water-Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers*, June 2005.

20. Ibid.
21. See note 6.
22. Thierry Boulinier, et al., "Higher Temporal Variability of Forest Bird Breeding Communities in Fragmented Landscapes," *Proceedings of the National Academy of Sciences*, 95: 7497-7501, June 1998.
23. Therese Donovan and Curtis Flather, "Relationships Among North American Songbird Trends, Habitat Fragmentation, and Landscape Occupancy," *Ecological Applications*, 12(2): 364-374, 2000.
24. See note 22.
25. Mid-Atlantic Regional Earth Science Applications Center, *Landscape Metrics Used to Assess Anthropogenic Influence on Wetlands in the Anacostia Watershed*, downloaded from www.geog.umd.edu/resac/anacos1.htm, 15 December 2008.
26. Maryland Department of Transportation, State Highway Administration, *Maryland Scenic Byways*, downloaded from www.sha.state.md.us/exploremd/oed/scenicbyways/scenicbyways.asp, 15 December 2008.
27. John Wennersten, "Waves of Sprawl Washing Bay's Identity from Landscape," *Bay Journal*, February 2008.
28. Civil War Preservation Trust, *History Under Siege: A Guide to America's Most Endangered Civil War Battlefields*, 2005.
29. Maryland Commission on Climate Change, *Climate Action Plan*, 27 August 2008.
30. 1990 population was 4,781,468, per U.S. Census Bureau, *1990 Census of Population and Housing*, "1990 Population and Housing Unit Counts: United States," (CPH-2). 2005 population was 5,573,163, per U.S. Census Bureau, *Annual Population Estimates, Estimated Components of Population Change and Rates of the Components of Population Change for the United States and States: April 1, 2000 to July 1, 2007*.
31. See note 29.
32. U.S. Census Bureau, *2007 American Community Survey*, downloaded from www.census.gov, 2 March 2009.
33. Ibid.
34. Assuming Marylanders have commutes of 30.2 minutes and work 247 days per year. Ibid.
35. See note 29.
36. Per note 29, on-road gasoline use accounted for 74 percent of emissions. Nationally, about 94 percent of the motor gasoline consumed in the transportation sector is used in light-duty cars and trucks (based on data from supplementary tables to U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2006*, February 2006), meaning that 69 percent of Maryland's transportation emissions come from cars and light trucks.
37. See note 29.
38. Ibid.
39. Ibid.
40. Ibid.
41. Ibid.
42. See note 1.
43. For the purposes of this analysis, the Baltimore metropolitan area is defined as Anne Arundel, Baltimore, Carroll, Harford and Howard counties and the Washington, D.C., area is defined as Calvert, Charles, Frederick, Montgomery and Prince George's counties. Baltimore City is not included in the Baltimore area data, nor is Queen Anne's County, which, while considered part of the Baltimore metropolitan area by the U.S. Census Bureau, is considered part of the Eastern Shore in this analysis. Cecil County is considered part of the Wilmington metropolitan area.
44. See note 1.

