Appendix B
Global Climate Change and Maryland

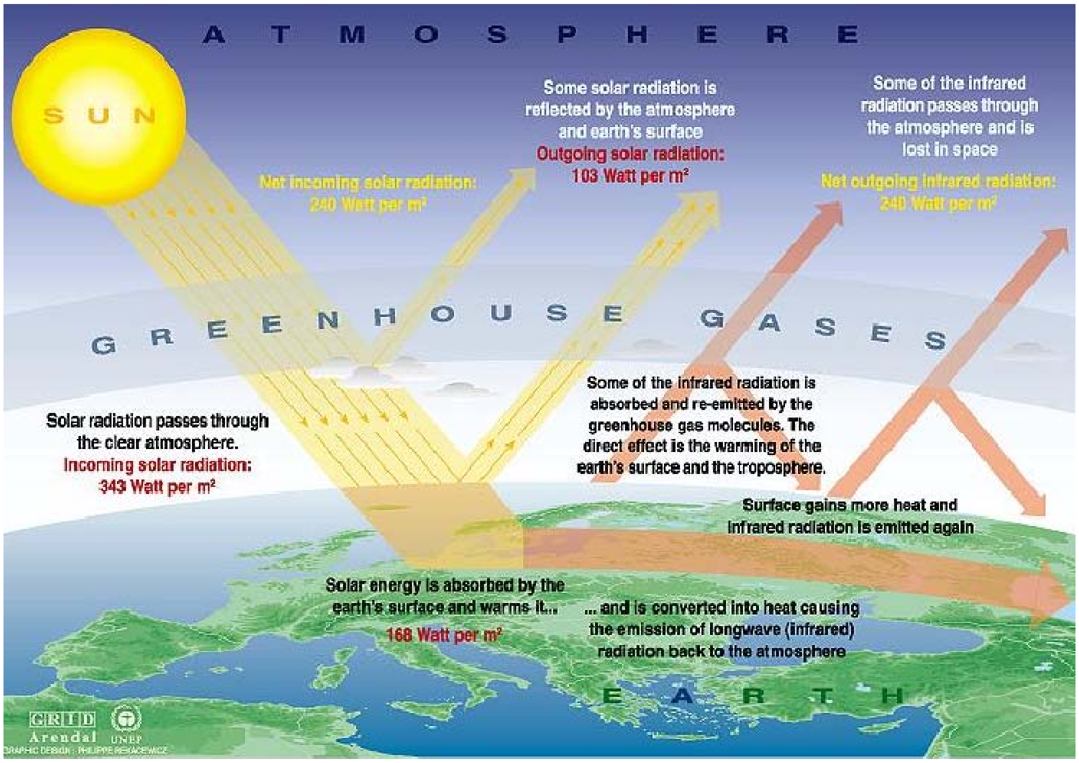
The amount of the sun's radiative heat that is trapped in the Earth's atmosphere is a key determinant of the planet's overall climate. There are many factors that control how much of this heat is trapped and how much is either reflected or re-radiated into space, including the magnitude of the solar radiation, the concentration of particles that reflect or block the incident radiation such as aerosols and cloud cover, and the concentration of greenhouse gases (GHGs).

GHGs are virtually transparent to sunlight (shortwave radiation), allowing it to pass through the air and to heat the Earth's surface. The Earth's surface absorbs the sunlight and emits thermal radiation (longwave radiation) back to the atmosphere. Because greenhouse gases are not transparent to the outgoing thermal radiation, some of the radiation is absorbed, and heats the atmosphere. In turn, the atmosphere emits thermal radiation both outward into space and downward to the Earth, further warming the surface. This balance of absorbed and re-radiated energy enables the Earth to maintain enough warmth to support life. Without this natural "greenhouse effect," the Earth would be approximately 55°F colder than it is today. However, human activities that lead to changes in the relative concentrations of climate controlling gases and particles are projected to result in increased average temperatures, with the potential to warm the planet to a level that could disrupt the activities of today's natural systems and human societies.[i]

Naturally occurring greenhouse gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Some human-made compounds — including chlorofluorocarbons (CFCs), partially halogenated fluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorinated carbons (PFCs) — are also greenhouse gases. In addition, there are photochemically important gases such as oxides of nitrogen (NOx) and non-methane volatile organic compounds (NMVOCs) that, although not greenhouse gases, contribute indirectly to the greenhouse effect by influencing the rate at which ozone and other greenhouse gases are created and destroyed in the atmosphere.

Each of these gases have different absorptive and reflective characteristics for different types of radiation, and each gas will therefore trap different amounts of solar energy. The "Global Warming Potential" (GWP) of a gas describes its relative ability to trap heat in the atmosphere, with CO_2 as the reference gas. In addition, each of the gases have different atmospheric lifetimes (the time before they chemically transform into a new substance), and will therefore trap heat for different lengths of time. To account for this, the GWP is stated in terms of a reference time frame, usually 100 years. Table below lists the GHGs, their lifetimes, and their respective GWPs.

Figure C-1. The Greenhouse Effect



Source: United Nations Environmental Program (UNEP),Global Resource Information Database, Arendal, Norway. Vital Climate Graphics. Website: http://www.grida.no/climate/vital/index.htm

Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, rising levels of these gases in the atmosphere are attributed mainly to anthropogenic activities (see Table). This buildup has altered the composition of the earth's atmosphere, and may affect the future global climate. Since about 1750, atmospheric concentrations of carbon dioxide have increased by about 31 percent, methane concentrations have increased by 149 percent, and nitrous oxide concentrations have risen approximately 16 percent (IPCC, 2001). Since 1960, CO_2 concentrations have risen by 15%, indicating that concentrations are growing at an increasing rate. Use of CFCs, on the other hand, grew by 10% between the 1950s through the mid-1980s, until international concern grew over the link between CFCs and ozone depletion, after which the use of these gases rapidly declined as prescribed under the Montreal Protocol on Substances that Deplete the Ozone Layer. Use of CFC substitutes (such as HCFCs and HFCs), in contrast, is expected to grow significantly.[ii]

While there is considerable agreement within the scientific community that "global average surface temperature has increased by between 0.4 and 0.8 degrees Celsius," and that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities," (IPCC, 2001), there is much less agreement about the timing, magnitude, or regional distribution of any climatic change. Uncertainties about the climatic roles of oceans and clouds as well as the feedback effects of oceans, clouds, vegetation, and other factors make it difficult to predict with certainty the amount of warming that rising levels of greenhouse gases will cause.

Table C-1. Atmospheric Lifetime and 100-year Global Warming Potential of Greenhouse Gases

Gas	Atmospheric Lifetime	100-year GWP
Carbon dioxide (CO2)	50-200	1
Methane (CH4)	12±3	21
Nitrous oxide (N2O)	120	310
HFC-23	264	11,700
HFC-125	32.6	2,800
HFC-134a	14.6	1,300
HFC-143a	48.3	3,800
HFC-152a	1.5	140
HFC-227ea	36.5	2,900
HFC-236fa	209	6,300
HFC-4310mee	17.1	1,300
CF4	50,000	6,500
C2F6	10,000	9,200
C4F10	2,600	7,000
C6F14	3,200	7,400
SF6	3,200	23,900

Source: Intergovernmental Panel on Climate Change (IPCC), Second Assessment Report (1996)

Table C-2. Changes in Atmospheric Concentrations of Key Greenhouse Gases

Atmospheric Variable	CO_2	CH_4	N_2O	SF_6[a]	SF_4[a]
Pre-industrial atmospheric concentration	278	0.7	0.27	0	40
Atmospheric concentration (1998)	365	1.745	0.314	4.2	80
Percentage Increase from Pre-Industrial	31%	149%	16%	n/a	100%
Rate of concentration change[b]	1.5[c]	0.007[c]	0.0008	0.24	1

[a] Concentrations in parts per trillion and rate of concentration change in ppt/year.
[b] Rate is calculated over the period 1990 to 1999.
Source: Intergovernmental Panel on Climate Change (IPCC), Second Assessment Report (1996)

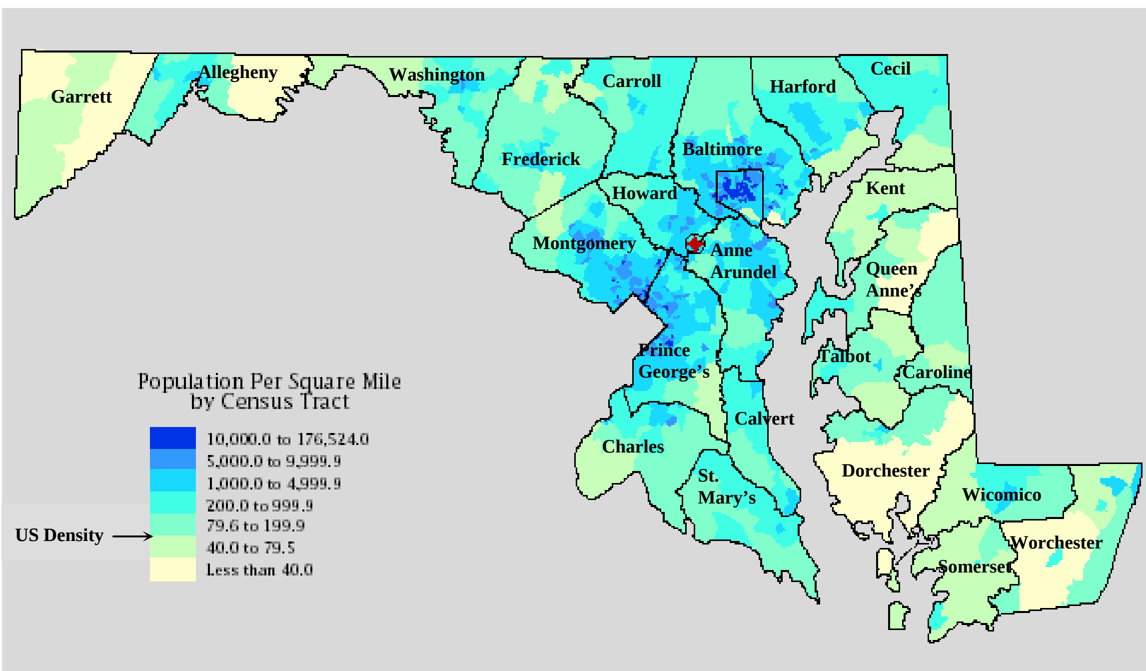
MARYLAND'S VULNERABILITY TO CLIMATE CHANGE

Much of this section draws directly from a report commissioned by the Maryland Energy Administration titled "Climate Change Impacts, Maryland Resources at Risk," written by Richard H. Moss, Elizabeth L. Malone, Sangamitra Ramachander, and Michelle R. Perez of the Joint Global Change Research Institute at the University of Maryland. Where other sources are used, they are referenced accordingly.[iii]

Statewide

According to the U.S. Census Bureau, Maryland's population in 2000 was 5,296,486—ranking 19th among U.S. states. With 529.1 persons per square land mile in 1999, it ranked 6th in population density among states (including the District of Columbia). The majority of Maryland's residents (~70%) live in one of the five counties contiguous to Baltimore and Washington, D.C. (See Figure C-2) From 1990 to 2000, Maryland population grew 10.8%, a gain of 515,733 persons. Calvert County led all other counties in that period with a 45.1% increase in population.

Figure C-2. Population Density in Maryland



Source: U.S. Census Bureau, "Census 2000: Maryland Profile"

Maryland's economy has been consistently strong over the past ten years, faring better than the national average in most key indices. In 2000, per-capita personal income grew 6.7% and ranked 5th in the nation at $33,621 per year. The unemployment rate in October 2003 was 4.1%, well below the 6.0% national average. During the economic slowdown of 2001, the job growth rate in Maryland fell to 1.4%, eighteenth highest in the nation, but twice the national average. Despite predictions of a continued slowdown into 2002, Maryland's job growth rate remains in positive territory while the national rate has shown zero or negative growth. Job losses have occurred in the State, however, especially in manufacturing, trade, and the travel and tourism sectors.[iv]

The State's economic strength derives from its high percentage of professional and technical workers; Maryland ranks first among the states in this category, at 25.1% of the workforce. Maryland's workforce is also among the best educated, with a third of its population aged 25 or older holding a bachelor's degree or higher (third highest among all states). Most Marylanders (86%) work in the widely defined service-producing sector. This category ranges from government positions to transportation-related professions, from wholesale trade to the finance and insurance industry, with 32% of the work force in the health, legal and education fields, and one in five residents work in retail trade or for the government.[v]

Federal agencies located in Maryland have been a catalyst for the State's technology base. These include the National Institutes of Health, the National Institute of Standards and Technology, the National Aeronautics and Space Administration, Goddard Space Flight Center, and Department of Defense operations. Advanced technology enterprise is especially strong in telecommunications, computer sciences, and biotechnology.[vi]

Manufacturing, a traditional mainstay of the State's economy, continues to play an important role. The State's manufacturing sector spans all industrial classifications, with particular strengths in food processing, computer and electronic products, industrial machinery and equipment, and printing and publishing. More than 180,000 are employed in Maryland's manufacturing sector.

Climate Change Vulnerability by Maryland Sub-Region

The vulnerability of a given region to the effects of climate change is dependent on the a number of factors including the geographic layout, the distribution of population, and the source of economic well being. Because Maryland is topographically and demographically diverse, with coastal areas, plains and mountains, along with cities, farming communities, and heavily developed commercial and residential corridors, it is useful to divide the State into three regions that represent the differences in climate change vulnerability: the Baltimore-Washington Corridor, the Coastal and Rural Area, and the Western Mountain Area.

The "Baltimore-Washington Corridor" is the largest area in population, geography, and economic importance, and is dominated by professional and business services, trade/transportation, and education/health. Jurisdictions within this region share a number of urban problems and attributes that might interact in similar ways with elevated temperatures, increased flooding and drought, and other changes associated with climate. These attributes include high population density and existing environmental problems such as poor air quality, water pollution, and associated stresses on urban ecosystems and public health. This region includes six counties and Baltimore City that are largely or partly classified as coastal plain in legal or geological perspective but that also cohere with the economic activities of the corridor region.

The “Coastal and Rural Area” includes ten counties whose economies and life-styles are influenced by their proximity to the Atlantic Ocean and the Chesapeake or other bays. Over 30 percent of the State’s economic activities related to natural resources are conducted in this region. These jurisdictions are not as urbanized and share characteristics with other rural and coastal regions of the United States that would lead their infrastructure, economies, and environments to confront similar issues in developing responses to sea level rise and heightened storm surges, or to other aspects of climate change that could affect agriculture.

The “Western Mountain Area” consists of three counties and contains abundant natural wealth in forests and other natural resources. This is the smallest region economically, and it has relatively low population density compared to that of the Baltimore- Washington corridor. Forestry and related manufacturing are important sources of employment, and the region includes ecosystems that distinct from those in other areas of the State. In addition, the region is home to skiing and other mountain and water-based recreation opportunities that are unique and potentially affected by climate change.

The Baltimore-Washington Corridor

The midsection of Maryland is the largest area in population, geography, and economic importance. More than 86 percent of the State’s population lives in this area (4,577,673 people), 46 percent of the State’s land is in this area, and 90 percent of the wages in the State are paid here. The State’s population is growing, on average 11 percent; however, the Baltimore-Washington Corridor area has seen both growth and decline from 1990 to 2000. Calvert County led all other counties with a 45 percent increase in population, while Baltimore City’s population has declined 12 percent. As a whole, the State’s population density is 529 per square mile (1999), the sixth highest in the nation; the central area’s density is higher, reaching a peak of 8,137 per square mile in Baltimore City.

Ten counties and Baltimore City comprise the Baltimore-Washington Corridor Area of Maryland. The ten counties are Frederick, Montgomery, Prince George’s, Charles, Calvert, Anne Arundel, Howard, Carroll, Baltimore, and Harford. Physiographically, most of this area lies in the Piedmont Plateau Province. Western Frederick County is part of the Blue Ridge Province. The six counties near the Chesapeake Bay and Baltimore City lie in the Atlantic Continental Shelf Province. Annapolis, the State capital, is located in Anne Arundel County on the western side of the Chesapeake Bay.

This area contain major north-south transportation routes, notably Interstate 95, which runs from Florida to Maine along the East Coast, and major freight and passenger rail routes that run through the DC Area and Baltimore. Light rail, commuter rail, bus systems, and 14 stations and associated rail for the DC Metro system are located in this area. Baltimore is also an important port on the east coast, and the BWI Airport is one of the fastest growing in the nation.

The major economic sectors in the Baltimore-Washington Corridor Area, measured in wage data, are Professional and Business Services ($3.4 billion); Trade, Transportation, and Utilities ($3.1 billion); and Education and Health ($2.4 billion). Other important sectors include Financial Activities ($1.6 billion), Manufacturing ($1.6 billion), and Construction ($1.5 billion). This area also generates 54 percent of the Maryland wages in Natural Resources and Mining. Of these sectors, several are probably much more important to the State than wage data indicate; at the state level, personal income accounts for only 54.7 percent of the gross state product in Trade, Transportation, and Utilities; only 23.6 percent in Financial Activities, and only 61.4 percent in Manufacturing.

Almost 10 percent of the businesses in the State (14,450) are located in Baltimore. The Port of Baltimore is a significant economic engine for the entire region, generating $1.8 billion in economic benefits annually and employing 127,000 Marylanders in maritime-related jobs.

General Risks Related to Climate/Weather

Weather-related risks were estimated by the Maryland Emergency Management Agency (MEMA) in 2000 (see Table). According to this study, the Baltimore-Washington Corridor Area has a high risk of drought (6 counties and Baltimore City), extreme heat, tornado and thunderstorms, with a lesser risk of flash/river flooding and winter weather, and of tidal/coastal flooding in Anne Arundel and Calvert Counties. These current levels of risk may increase under climate change. If so, the risks may all become higher except for winter weather (snow and ice), which may decrease if snow is replaced by rain but may also increase if snow is replaced by ice storms. For more details on how these risks were determined, please see “Climate Change Impacts, Maryland Resources at Risk,” by Richard H. Moss, Elizabeth L. Malone, Sangamitra Ramachander, and Michelle R. Perez of the Joint Global Change Research Institute at the University of Maryland.

Table C-3. Weather Related Risks in the Baltimore-Washington Corridor Counties

	High Risk	**Medium-High Risk**
Drought	Frederick, Montgomery, Howard, Carroll, Baltimore City and County, Harford	None
Extreme Heat	Baltimore City	Frederick, Prince George's, Charles, Calvert, Howard, Anne Arundel, Harford
Flash/River Flooding	Frederick	Montgomery, Carroll, Baltimore County, Anne Arundel
Thunderstorm	Frederick, Montgomery, Anne Arundel	Prince George's, Carroll, Howard, Baltimore County, Harford
Tornado	Frederick, Anne Arundel	Prince George's, Charles, Carroll, Baltimore County, Harford
Winter Weather (Snow and Ice)		Frederick, Montgomery, Prince George's, Anne Arundel, Howard, Carroll
Tidal/Coastal Flooding		Anne Arundel, Calvert

Source: Maryland Emergency Management Administration, *Maryland Hazard Analysis*, Koontz, Michael, et. al. GEOMET Technologies Inc., and Towson University, Department of Geography. January, 2000.

Water Resources

Maryland's current water management infrastructure was developed for the current climate. However, climate change may bring both more floods and more droughts, and these extreme events could be more frequent and severe. High-intensity precipitation can result in combined sewage overflows and consequent pathogen loading for drinking water systems. Health impacts from waterborne diseases are likely, although they may be controllable by good public health systems. The problems of drought have been felt in Maryland in recent years, with implications for the availability of water for agricultural, industrial, and household uses— as well as for recreational purposes such as boating and fishing. The drought emergency of 1999 challenged the longstanding perception that the State of Maryland had an adequate supply of water for all uses. That drought demonstrated that water quantity and quality are interdependent; salinity levels increased and dissolved oxygen (necessary for aquatic life) fell when surface water flows fell in some areas.

Power outages from storms may be the most frequent weather-related problem for water resources because these outages affect the ability to pump water. The Mid-Atlantic Assessment Report states, "Perhaps surprisingly, larger systems report more weather-related problems than do smaller systems. Larger systems often draw on more than one source of water; this complexity may increase their vulnerability to extreme weather" and associated power disruptions.

Urban Areas

Because this area is the most densely settled in the State and the population is growing, the effects of climate on urban areas will be important here. Heat islands may get hotter as paved-over urban areas may experience increased incidences of sweltering temperatures. The combined effects of poor air quality,[1] ground-level ozone, and urban heat islands will take a toll on health. For example, asthma and other respiratory diseases have been linked to fine particulates in the lower atmosphere; larger urban populations and more traffic congestion in a warmer climate will worsen these health effects. Heat-induced deaths may increase, although this cause of death will continue to be minor compared to others. These dis-amenities may make the State's urban areas less desirable places to live, and this could in turn have a multiplicative effect on real estate values, costs of health care and health insurance, tax revenues, and so on.

Much of Maryland's loss of forestland is occurring where the trees are needed most, in the urbanized areas of the State. Forests are especially crucial in urbanized areas. One acre of young healthy trees will absorb 2.5 tons of carbon dioxide and give off 2 tons of oxygen each year. Trees also contribute to the improvement of air quality, help control water runoff, moderate the effects of urban heat islands, and often represent the presence of recreational and park spaces.

The Coastal and Rural Area

Ten counties are located in the Coastal and Rural Area of the State. Worcester County borders the Atlantic Ocean, while 7 counties border the eastern side of the Chesapeake Bay: Cecil, Kent, Queen Anne's, Talbot, Dorchester, Wicomico, and Somerset Counties; Caroline County lies near the eastern side of the Bay, and St. Mary's is located on the southwestern side of the Chesapeake Bay. Although comprising 38 percent of the State's land area, less than 10 percent of the State's population (482,114 people) resides in these 10 counties and only 7 percent of the wages in the State are paid here. Population density in these coastal and rural areas is only 112 people per square mile, in contrast to the state average of 529 people per square mile. The State's population is growing 11 percent per year on average and all of these counties have experienced growth, ranging from 1.4 percent in Dorchester to 32.9 percent per year in Worcester.

The major economic sectors in the Coastal and Rural Area, measured in wage data, are Trade, Transportation, and Utilities ($239 million); Education and Health ($164 million); and Professional and Business Services ($154 million). Other important sectors include Leisure and Hospitality ($106 million), Construction ($80 million), and Financial Activities ($50 million). Over 30

[1] In the eastern mid-Atlantic region, a 2.22°C (4°F) warming, with no other change in weather or emissions, could increase concentrations of ground level ozone by 4%. Source: U.S. Environmental Protection Agency, Office of Policy. Report #: EPA 236-F-98-007l "Climate Change and Maryland," September 1998.

percent of the State's Natural Resource and Mining economic activities (mainly farming and fisheries), as measured by wages, are conducted in these 10 counties, while 12 percent of the Leisure and Hospitality activities and 10 percent of the Manufacturing activities occur here. Agricultural output includes corn, soybeans, and hay, as well as chicken growing and processing. Dockside value for commercial fisheries landings in the Chesapeake Bay, including Maryland's signature species, the blue crab, totaled more than US $172 million in 2000 or five percent of the harvest value from all states combined.

Wetlands (tidal and nontidal) are the dominant ecosystem on the eastern shore area, where most of the land area is only five feet above sea level. In addition, many waterways that are important for agricultural and recreational activities bisect this region, including the Wicomico, Choptank, Wye, Sassafras, and Elk Rivers. Ocean City and Assateague Island in Worcester County are some of the most popular East Coast tourist destinations, and Blackwater National Wildlife Refuge in Dorchester County provides tourists with wildlife and bird watching recreational activities.

The Coastal and Rural Areas of Maryland may be the most affected area in the State by both the direct and indirect effects of climate change. Because these Coastal and Rural Areas rely heavily on the estuarine, ocean, and wetland ecosystems for many of the fisheries and recreational activities for which the State is known, these ten counties may become among the most significantly impacted by climate change. And because climate change may have different effects on different plant and animal species and economic sectors, there may be some "winners" and some "losers."

General Risks Related to Climate/Weather

Weather-related risks were estimated by the Maryland Emergency Management Agency (MEMA) in 2000 (see Table). The coastal and rural counties show a relatively high risk for a variety of climate-change induced storm events, particularly tidal/coastal flooding and tropical cyclones. Risks were generally estimated using historical data for frequency and severity of occurrences.

Table C-4. Maryland Weather Related Risks in Coastal and Rural Counties

	High Risk	**Medium-High Risk**
Drought	Cecil	
Extreme Heat		Cecil, Kent, Caroline
Tidal/Coastal Flooding	Dorchester, Worcester	Kent, Talbot, Queen Anne's
Tropical Cyclone	Somerset, Worcester	Talbot, Dorchester, Wicomico
Thunderstorm		Cecil
Tornado		St. Mary's

Source: Maryland Emergency Management Administration, *Maryland Hazard Analysis*, Koontz, Michael, et. al. GEOMET Technologies Inc., and Towson University, Department of Geography. January, 2000.

Coastal Infrastructure

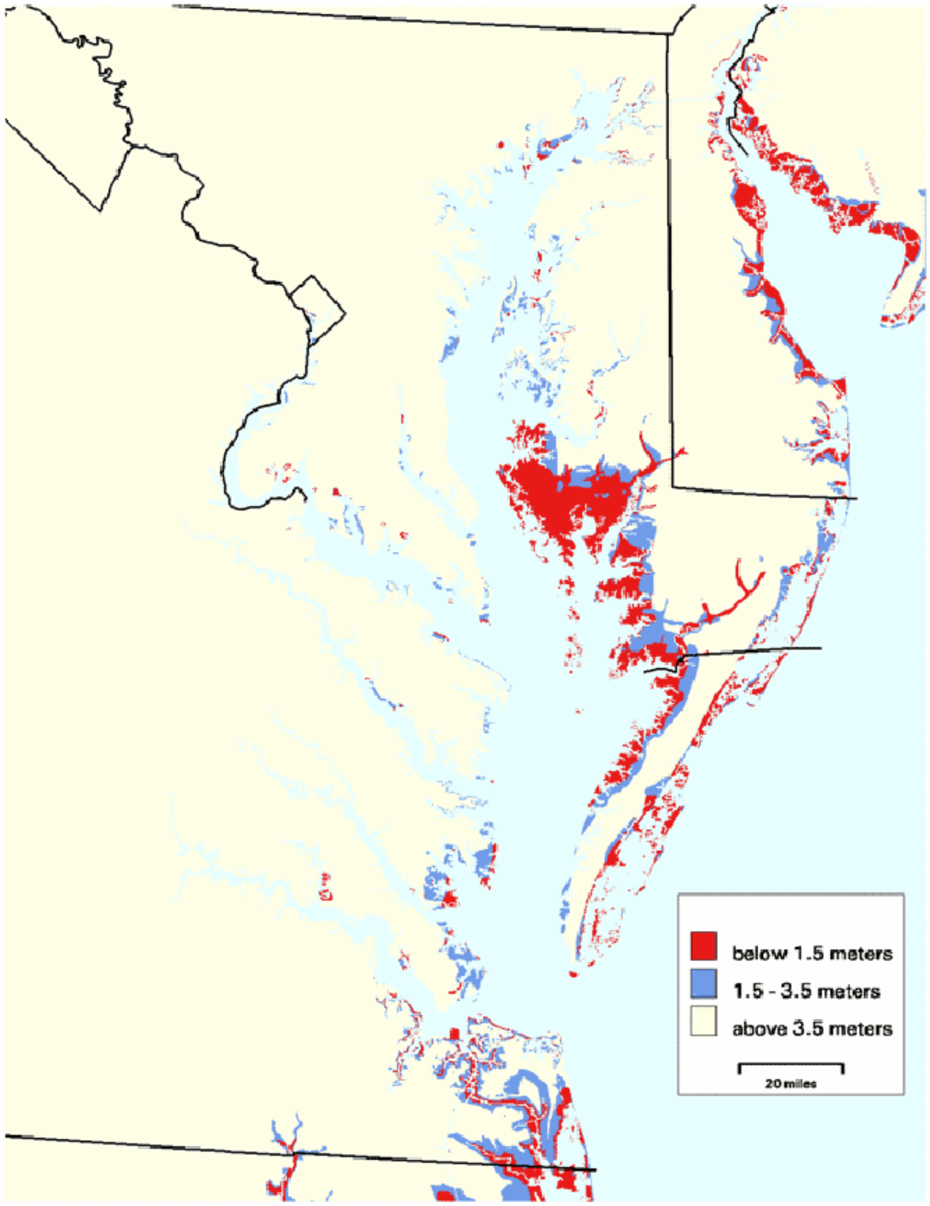
In the course of the past century, global sea levels have steadily risen. One EPA study[vii] projects that, in response to climate change, sea levels will continue to rise. Average sea level along Maryland's 4,360-mile coastline has been rising approximately one foot per century. Over 30 percent of Maryland's coastline currently undergoes some degree of shore erosion, which results in the loss of about 260 acres per year. Climate change may increase the rate to nearly two to three feet by the year 2100. Impacts of sea level rise include shoreline erosion, flooding, inundation, and changes in salinity and water temperature. The level of impact of climate change will be determined by the characteristics of a given region. These eastern shore counties tend to have lower topographic elevations than western shore counties. Areas of lower relief will be more vulnerable to storm surge and sea level rise, since rising waters will travel further inland along low elevation shorelines for each foot of increased water level. A one-foot rise in sea level may result in a one-foot rise in flood level, thus exacerbating the impact of episodic storm flooding in coastal communities. Counties toward the southern end of the Chesapeake Bay like Dorchester, Wicomico, and Somerset may experience the most damage from sea level rise, because a significant portion of the these counties is less than five feet above sea level; large portions of the land area may be inundated at high tide if sea level rises a foot and a half or more. Beach replenishment, used to counter shoreline erosion, is already an annual cost to many coastal communities and governments. In addition, costs of sea level rise may include damage to valuable beachfront real estate, scenic roads, and infrastructure such as sewers.

Figure C-3 below illustrates the potential for coastal inundation from sea level rise. Red areas indicate some of the areas that could be flooded at high tide if global warming causes sea level to rise 2 feet by 2100. Blue areas are those that might be inundated over a period of several centuries. Approximately 1000 square miles of land in Maryland and Virginia could be inundated by the tides if sea level rises two feet. The indicated areas account not only for the effects of global warming, but also for other effects such as tidal variations and land subsidence.[viii]

Fresh Water Resources

Over 80 percent of Marylanders in the Coastal and Rural Area of the State rely on groundwater for their source of drinking water. Should precipitation levels fail to recharge the aquifers faster than water is withdrawn for agricultural and residential purposes, the aquifers could fail to meet the needs of the nine counties on the Eastern Shore. In addition, saltwater intrusion into the wells from subsidence and sea level rise could contaminate the wells and make them too salty for drinking and irrigation purposes.

Figure C-3. Sea Level Rise in the Chesapeake Bay Region



Source: J.G.Titus and C.Richman, 2000, “Maps of Lands Vulnerable to Sea Level Rise: Modeled Elevations Along the U.S. Atlantic and Gulf Coasts.” *Climate Research*

Farming

Climate change is likely to bring with it both negative and positive agricultural impacts. Some agricultural sectors may benefit from rising atmospheric concentrations of carbon dioxide. Crops use carbon dioxide in photosynthesis, so, as atmospheric concentration increases, growth rates may also increase. The extent of this “CO_2 fertilization effect” is the subject of much current research. In particular, if farmers are able to adapt to climate change, soybean, corn and tree fruit production may increase. However, increased carbon dioxide may also promote the growth of weeds and may result in the need for higher doses of herbicides. It is uncertain how changes in temperature, precipitation, and extreme weather may impact agriculture. Contrary to the benefits of increased carbon dioxide on crops, warmer temperatures may increase the survivability of insect pests over winter and encourage fungal disease development. In addition, more frequent droughts may increase stress to crops, which would lower food production. Finally, salt-water intrusion into agriculturally important waterways on the Eastern Shore from rising sea level may increase salinity beyond crop tolerance. Corn, for example, can only tolerate salinity of one to two parts per thousand and soybeans about three-tenths part per thousand. Where irrigation intakes are located in tidally influenced areas, farmers may have to avoid using irrigation water from tidal rivers; this, in turn, may put more pressure on groundwater aquifer withdrawal.

Fisheries, Wetlands, and Habitat

Climate change may have a variety of direct and indirect impacts on the Chesapeake Bay, which ranks third (after the Atlantic and Pacific Oceans) in the nation's fishery catch. A primary response to climate change in the State may be a 2º F rise in air temperature by 2030 and 8º F increase by 2100. Because air temperature accounts for 70 to 90 percent of the variance in upper Chesapeake Bay water temperature, researchers estimate Bay water temperature may increase by the same amount. Warmer water temperatures may shorten the winter season in the Bay and allow earlier spring immigration and later emigration of many coastal species that use the Bay as a seasonal feeding ground or nursery area. Some of the most sought-after species by both commercial and sport fisherman are the migratory species, such as the Maryland blue crab. Because warmer water holds less oxygen, dissolved oxygen levels (an indicator of the general ecological health of water bodies) may decrease. Drought conditions would reduce flow from the Bay's three largest tributaries, the Susquehanna, Potomac and James, resulting in greater salinity conditions in the Bay. "Winners" under drought conditions could include oysters, anchovies, and hard clams. Oysters, should they fall prey to their diseases that thrive under saline conditions, could become "losers" during drought conditions, as could underwater grasses that cannot tolerate too much salinity. The fishing industry as a whole could become a major loser if drought conditions affect the health of fish, as in the outbreak of dead and diseased fish attributed to *Pfiesteria* in 1997, triggering fishing closures and bans on fish consumption.

Climate change could undermine the efforts to restore the Bay's underwater grasses, which provide essential habitat for many important Bay creatures, especially during the juvenile stage of their life cycle. In addition to higher salinity problems, higher sea levels could deepen the habitat for the submerged aquatic vegetation (SAV) and, together with shoreline erosion, could reduce the plants' ability to receive sunlight due to increased suspended sediment.

Wetlands such as freshwater and salt marshes dominate the shoreline in the eastern side of the Chesapeake Bay. Wetland ecosystems provide habitat for food, shelter, spawning, nesting and predation activities for commercially important species such as striped bass, herring, spot, summer flounder, blue crab, eastern oyster and horseshoe crabs. Wetlands reduce erosion, mitigate flooding, and slow runoff so that nutrients and pollutants are trapped before entering coastal waters. Climate change could essentially “drown” marsh grasses and wetlands faster than they could migrate upland; migration potential is not only topography dependent, but also dependent on coastal development levels. A similar problem could affect the barrier islands, especially Assateague, which already migrate. If sea level rises too rapidly, the whole of Assateague Island could disappear. Blackwater Wildlife Refuge has experienced particularly severe wetlands deterioration from the combination of shoreline erosion, and subsidence caused by groundwater aquifer withdrawal for agricultural purposes, and sediment and nutrient problems.

Western Mountain Area

The Western Mountain region consists of 3 counties – Garrett, Allegany, and Washington – and comprises only about 16 percent of the total land area in Maryland. It is bounded by West Virginia, Pennsylvania and the Potomac River. Lying in the west of the State, the region includes the land areas of the Appalachian Plateau, the Appalachian Ridge and Valley, and the Blue Ridge.

This region is known primarily for its natural beauty and abundant opportunities for outdoor recreation. It contains 4 of the 7 state forests in Maryland, 5 wildlife management areas, 13 state parks, the Appalachian Mountains, three rivers and the State’s largest body of fresh water, Deep Creek Lake. Attractions include whitewater rafting and kayaking, fishing, swimming, wilderness hiking, mountain biking, bird watching, camping, golfing and skiing. The region contains less than 5 percent of the State’s population, and has a low population density of 146 people per square mile compared to the state average of 529. The growth rate of population between 1990 and 2000 ranged from zero in Allegany County to 9 percent in Washington County, compared to the state average of 11 percent. Despite its abundant natural wealth, only 3 percent of total wages accrue to this region. The major economic sectors in this area measured in wage data are Trade, Transportation, and Utilities ($130 million); Manufacturing ($123 million); and Education and Health ($109 million). Other important sectors include Financial Activities ($62 million), Construction ($44 million), and Professional and Business Services ($42 million). Leisure and Hospitality accounts for only $26 million, or 3% of the economic activity in this region.

General Risks Related to Climate/Weather

Table below indicates weather-related risks estimated by the Maryland Emergency Management Agency (MEMA) in 2000. It points out the high risk of changes in winter weather in Garrett County and a medium-high risk for the rest of the region. However, it is difficult to say what the outcome of changes in winter temperatures will be – on one hand, snow may be replaced by rainfall, which would decrease risks associated with snow, but, on the other hand, snow may be replaced by ice storms, in which case the risk may increase.

Table C-5. Maryland Weather Related Risks in Western Mountain Counties

	High Risk	**Medium-High Risk**
Drought		Allegany, Washington
Extreme Heat		Washington
Flash/River Flooding	Allegany	Washington
Thunderstorm		Washington
Tornado		Garrett
Winter Weather (Snow and Ice)	Garrett	Allegany, Washington

Source: Maryland Emergency Management Administration, *Maryland Hazard Analysis*, Koontz, Michael, et. al. GEOMET Technologies Inc., and Towson University, Department of Geography. January, 2000.

Forestry

The mountain areas of western Maryland contain a variety of oak forests and northern hardwoods (beech, birch and maple trees). Forest products are a large industry in Maryland, employing more than 15,500 people; the industry is the largest employer in Garrett and Allegany Counties. The forest products industry is diverse, including sawmills, a paper mill, pulpwood operations, family-owned logging companies, firewood operators, whole-tree chippers, and veneer log buyers, as well as producers of furniture, cabinets and other secondary wood products. In 1993, income from timber sold in Maryland was estimated to be $29.3 million. Studies show that for every $1 paid to landowners for the sale of timber in 1993, $14 was generated for the State's economy.

Climate change is likely to reduce the dominance of maple-beech-birch forests in the mid-Atlantic region with an increase in oak-hickory forests, and to a lesser extent, southern pine and mixed oak-pine forests. However, it is not known how these changes will take place. If the changes take many decades, people will have the opportunity to adapt and to slowly change their forestry practices as the species mix changes. However, the shifts in forest types and their location could diminish the competitiveness of the many small hardwood processors of the western region in the short or medium term. Since there are strong inter-linkages between this industry and the rest of the economy – studies indicate that the primary wood manufacturing industry has the highest employment multiplier of all industries in the State – ripple effects will be felt across the State. Moreover, if the rate of change is faster than that of new tree growth, existing species may die before replacement species can mature unless tree planting programs are implemented.

Yet another industry at risk is the current maple syrup industry in this region. According to the New England regional assessment study, there is a migration of this industry towards the north due to climate factors. The study explains that maple syrup production in New England depends on the proper combination of freezing nights and warmer daytime temperatures, as well as prolonged cold temperatures in February and March. However, climate conditions appropriate for sustained sap flow are now more favorable in Canada and less so in New England, which has warmer daytime and nighttime temperatures, and therefore the industry has moved north. In 1928, the center of maple syrup production in the United States was in Garrett County, Maryland.

[i] U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation, State and Local Climate Change Program, “States Guidance Document Policy Planning to Reduce Greenhouse Gas Emissions, Second Edition,” May 1998.

[ii] ibid.

[iii] Moss, Richard H., Elizabeth L. Malone, Sangamitra Ramachander, and Michelle R. Perez. “Climate Change Impacts, Maryland Resources at Risk.” Joint Global Change Research Institute at the University of Maryland. July 2, 2002.

[iv] Maryland State Archives website. “Maryland at a Glance,” http://www.mdarchives.state.md.us/msa/mdmanual/01glance/html/economy.html (December 1, 2003)

[v] ibid.

[vi] ibid.

[vii] Titus, James G., and Vijay. Narayanan. “The Probability of Sea Level Rise.” US Environmental Protection Agency, 1995.

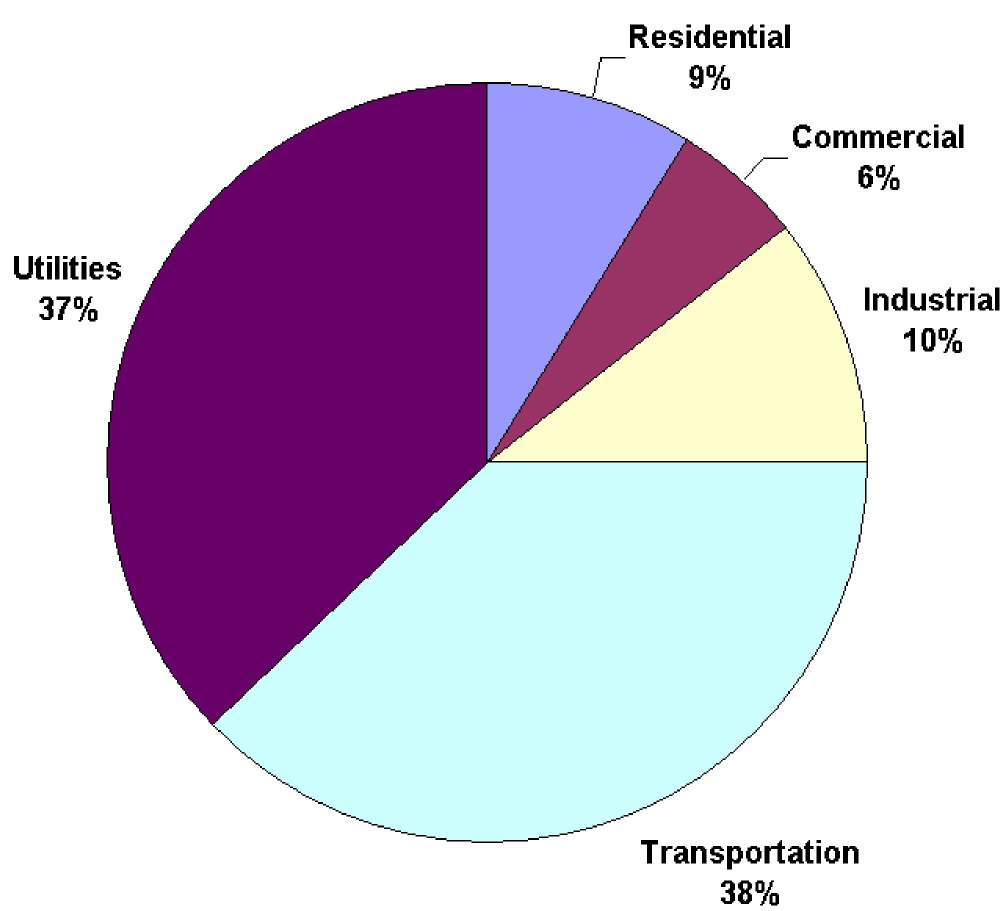
http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsProbability.html (December, 29 2003)

[viii] Titus, James G., and C. Richman, “Maps of Lands Vulnerable to Sea Level Rise: Modeled Elevations Along the U.S. Atlantic and Gulf Coasts.” *Climate Research.* 2000.

Appendix A
Maryland's GHG Emissions

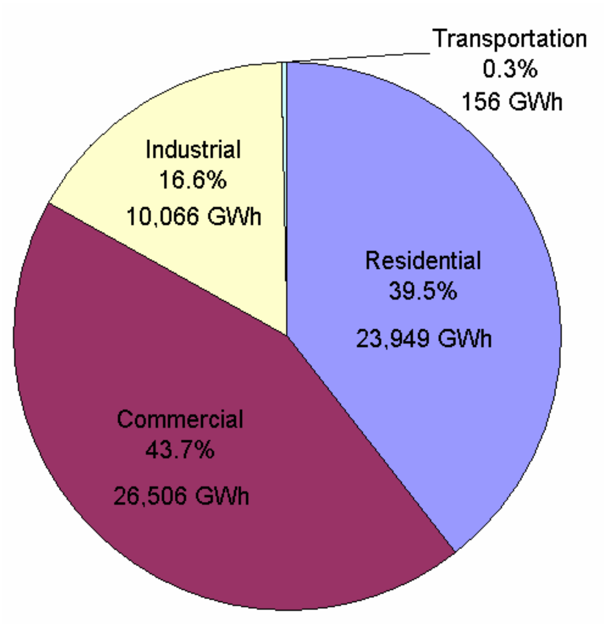
More than 90 percent of Maryland's greenhouse gas (GHG) emissions take the form of carbon dioxide emissions (CO_2) from fossil fuel combustion—about 76.3 million tons of CO_2 were emitted in 1999. The transportation and electric utility sectors respectively accounted for 37 and 38 percent of this sum. The industrial, residential, and commercial sectors accounted for 10, 9, and 6 percent, respectively. (See Figure 2).[i] And within the electric utility sector, end use electricity consumption was divided between the residential, commercial, industrial, and transportation sectors as shown in Figure 3.

Figure 1. Sectoral Share of Combustion CO_2 Emissions in Maryland, 1999



Source: Maryland Department of Environment

Figure 2. Electricity Consumption Breakdown by Sector, 2000



Source: U.S. Department of Energy, Energy Information Administration State Energy Data 2000, March 2003.http:www.eia.doe.gov/emeu/states.

If Maryland were an independent country, it would rank 13th worldwide in terms of total CO_2 emissions (see Table 1). Among U.S. states it ranks 26th overall, 36th in CO_2 emissions per capita (24% below the national average), and 37th in CO_2 emissions per dollar of Gross State Product (GSP) (25% below the national average – see Table 2).

Table 1. CO_2 Emissions for Various Countries, Regions, and States in 1998

Country/ Region/State	CO_2 Emissions* (MMTCE)	Share of World Total	Country/ Region/State	CO_2 Emissions* (MMTCE)	Share of World Total
World	**6,091**	**100.0%**	Canada	150	2.5%
United States	**1,511**	**24.8%**	Italy	121	2.0%
China	669	11.0%	Mexico	101	1.7%
Former Soviet Union	607	10.0%	France	109	1.8%
Japan	307	5.0%	Australia	115	1.9%
India	242	4.0%	Belgium	28	0.5%
Germany	230	3.8%	Maryland	**20**	**0.3%**
United Kingdom	151	2.5%	Austria	17	0.3%

* Emissions levels may vary from national and state authored reports.
Source: Schmidt, Jake, Stacey Davis, Alexandra Mackie, Greg Dierkers, Center for Clean Air Policy. "State and Local Climate Change Actions: Building Action from the Bottom-Up," Updated as of August 15, 2002.

Table 2. State Ranking for Carbon Emissions and Intensities (per Capita and Unit GSP)

Total 1999 CO2 Emissions Million Metric Tons Carbon			CO2 Emissions per Capita (1999) Metric Tons Carbon per Capita			CO2 Emissions per $GSP (1999) Metric Tons Carbon per MM$		
State	**Value**	**Rank**	**State**	**Value**	**Rank**	**State**	**Value**	**Rank**
Texas	166.6	1	Wyoming	34.0	1	Wyoming	822.3	1
California	94.8	2	North Dakota	21.5	2	North Dakota	727.2	2
Ohio	69.8	3	Alaska	17.6	3	West Virginia	723.4	3
Pennsylvania	64.1	4	West Virginia	16.9	4	Alaska	385.9	4
Florida	60.8	5	Louisiana	11.4	5	Montana	369.8	5
Indiana	59.9	6	Indiana	9.8	6	Louisiana	344.1	6
Illinois	58.6	7	Montana	9.3	7	Indiana	315.1	7
Michigan	53.0	8	Kentucky	9.0	8	Kentucky	302.9	8
New York	52.3	9	New Mexico	8.3	9	Alabama	295.5	9
Louisiana	51.2	10	Alabama	8.1	10	New Mexico	272.4	10
Georgia	43.1	11	Texas	8.0	11	Oklahoma	266.8	11
North Carolina	37.2	12	Utah	7.4	12	Mississippi	254.0	12
Kentucky	36.4	13	Oklahoma	7.3	13	Arkansas	251.6	13
Alabama	35.9	14	Kansas	7.2	14	Utah	235.8	14
Missouri	35.2	15	Iowa	7.1	15	Iowa	227.1	15
Tennessee	32.4	16	Nebraska	6.5	16	Kansas	222.8	16
New Jersey	32.1	17	Arkansas	6.4	17	Texas	218.0	17
West Virginia	30.7	18	Missouri	6.3	18	Nebraska	195.0	18
Virginia	29.6	19	Ohio	6.1	19	Missouri	193.8	19
Wisconsin	28.0	20	Mississippi	6.0	20	Ohio	186.6	20
Oklahoma	25.0	21	Tennessee	5.7	21	South Carolina	181.7	21
Minnesota	25.0	22	Delaware	5.5	22	Tennessee	177.3	22
Washington	23.1	23	Nevada	5.5	23	Michigan	165.3	23
Arizona	21.5	24	Michigan	5.3	24	Wisconsin	157.7	24
Colorado	21.3	25	Georgia	5.3	25	Pennsylvania	156.8	25
Maryland	**21.2**	**26**	South Carolina	5.2	26	South Dakota	149.7	26
South Carolina	20.9	27	Pennsylvania	5.2	27	Georgia	143.8	27
Iowa	20.7	28	Wisconsin	5.2	28	Nevada	137.7	28
Kansas	19.4	29	Minnesota	5.1	29	North Carolina	134.9	29
Massachusetts	17.2	30	Colorado	5.0	30	Arizona	133.6	30
Arkansas	17.1	31	South Dakota	4.8	31	Minnesota	133.0	31
Mississippi	17.1	32	Illinois	4.7	32	Maine	129.8	32
Wyoming	16.8	33	North Carolina	4.6	33	Florida	123.8	33
Utah	16.6	34	Arizona	4.2	34	Illinois	123.2	34
New Mexico	15.1	35	Virginia	4.2	35	Colorado	122.7	35
North Dakota	13.8	36	**Maryland**	**4.0**	**36**	Idaho	111.4	36
Oregon	11.2	37	Washington	3.9	37	**Maryland**	**108.5**	**37**
Nebraska	11.1	38	New Jersey	3.8	38	Virginia	108.5	38
Alaska	11.0	39	Maine	3.8	39	Delaware	106.1	39
Nevada	10.9	40	Florida	3.8	40	Washington	103.7	40
Connecticut	10.1	41	New Hampshire	3.7	41	Hawaii	97.2	41
Montana	8.4	42	Hawaii	3.5	42	New Hampshire	96.4	42
Maine	4.9	43	Oregon	3.3	43	Oregon	93.6	43
New Hampshire	4.6	44	Idaho	3.2	44	Vermont	92.4	44
Delaware	4.3	45	Connecticut	3.0	45	New Jersey	87.9	45
Hawaii	4.3	46	Rhode Island	2.9	46	Rhode Island	83.4	46
Idaho	4.1	47	Vermont	2.9	47	California	69.8	47
South Dakota	3.6	48	California	2.8	48	New York	63.3	48
Rhode Island	3.1	49	New York	2.8	49	Connecticut	60.7	49
Vermont	1.8	50	Massachusetts	2.7	50	Massachusetts	59.6	50

Source: Energy Information Administration, State Energy Data Report 1999

In terms of energy efficiency, Maryland does relatively well compared to other states, ranking 42nd in total energy consumed per capita and 43rd in total energy consumed per dollar of GSP—again, about 25% less than the national average for both measures (see Table 3). In terms of residential sector energy consumption per capita, Maryland fares less well, with a rank of 32 among states, which is nearly equal to the national average. In the transportation sector, Maryland's per capita energy consumption ranks 45th—or 20% less than the national average.

Table 3. State Ranking for Energy Consumption and Intensities (per Capita and Unit GSP)

Total 1999 Energy Consumption Trillion BTU			Energy Consumption per Capita (1999) Million BTU per Capita			Energy Consumption per $GSP (1999) Metric Tons Carbon per MM$		
State	**Value**	**Rank**	**State**	**Value**	**Rank**	**State**	**Value**	**Rank**
Texas	11,501	1	Alaska	1,108	1	Louisiana	24,314	1
California	8,375	2	Wyoming	854	2	Alaska	24,306	2
Ohio	4,323	3	Louisiana	809	3	Wyoming	20,658	3
New York	4,283	4	North Dakota	569	4	North Dakota	19,242	4
Illinois	3,883	5	Texas	552	5	Montana	18,220	5
Florida	3,853	6	Montana	457	6	Mississippi	18,004	6
Pennsylvania	3,716	7	Kentucky	453	7	Arkansas	17,724	7
Louisiana	3,615	8	Alabama	451	8	West Virginia	17,357	8
Michigan	3,240	9	Arkansas	450	9	Alabama	16,502	9
Georgia	2,798	10	Indiana	450	10	Kentucky	15,218	10
Indiana	2,736	11	Mississippi	425	11	Texas	15,056	11
New Jersey	2,589	12	Maine	415	12	Oklahoma	14,677	12
North Carolina	2,447	13	West Virginia	407	13	Indiana	14,405	13
Washington	2,241	14	Idaho	401	14	Maine	14,115	14
Virginia	2,227	15	Oklahoma	399	15	Idaho	14,044	15
Tennessee	2,071	16	Kansas	391	16	South Carolina	12,960	16
Alabama	2,005	17	Iowa	383	17	Iowa	12,334	17
Kentucky	1,830	18	Ohio	381	18	Kansas	12,042	18
Wisconsin	1,811	19	Washington	380	19	Ohio	11,569	19
Missouri	1,768	20	South Carolina	372	20	New Mexico	11,457	20
Minnesota	1,675	21	Tennessee	364	21	Tennessee	11,344	21
Massachusetts	1,569	22	Delaware	356	22	Nebraska	10,568	22
South Carolina	1,493	23	Nebraska	352	23	Wisconsin	10,208	23
Maryland	**1,378**	**24**	New Mexico	349	24	Michigan	10,109	24
Oklahoma	1,378	25	Georgia	342	25	Washington	10,051	25
Arizona	1,220	26	Minnesota	341	26	Utah	9,855	26
Mississippi	1,209	27	Wisconsin	338	27	South Dakota	9,855	27
Arkansas	1,204	28	Michigan	326	28	Missouri	9,741	28
Colorado	1,156	29	Oregon	324	29	Georgia	9,331	29
Iowa	1,122	30	South Dakota	317	30	Oregon	9,239	30
Oregon	1,109	31	Missouri	316	31	Pennsylvania	9,098	31
Kansas	1,050	32	Virginia	315	32	Minnesota	8,909	32
Connecticut	839	33	Illinois	313	33	North Carolina	8,878	33
West Virginia	735	34	Utah	311	34	Vermont	8,617	34
Alaska	695	35	Nevada	308	35	Illinois	8,165	35
Utah	694	36	New Jersey	308	36	Virginia	8,157	36
New Mexico	635	37	North Carolina	304	37	Florida	7,839	37
Nevada	615	38	Pennsylvania	303	38	Nevada	7,767	38
Nebraska	602	39	New Hampshire	271	39	Arizona	7,591	39
Maine	529	40	Vermont	271	40	New Hampshire	7,108	40
Idaho	518	41	Colorado	269	41	New Jersey	7,085	41
Wyoming	422	42	**Maryland**	**260**	**42**	Rhode Island	7,068	42
Montana	412	43	Rhode Island	249	43	**Maryland**	**7,067**	**43**
North Dakota	366	44	California	247	44	Delaware	6,882	44
New Hampshire	335	45	Massachusetts	247	45	Colorado	6,650	45
Delaware	279	46	Connecticut	246	46	California	6,162	46
Rhode Island	261	47	Florida	241	47	Hawaii	5,523	47
Hawaii	241	48	Arizona	238	48	Massachusetts	5,452	48
South Dakota	239	49	New York	226	49	New York	5,182	49
Vermont	165	50	Hawaii	199	50	Connecticut	5,051	50

Source: Energy Information Administration, State Energy Data Report 1999

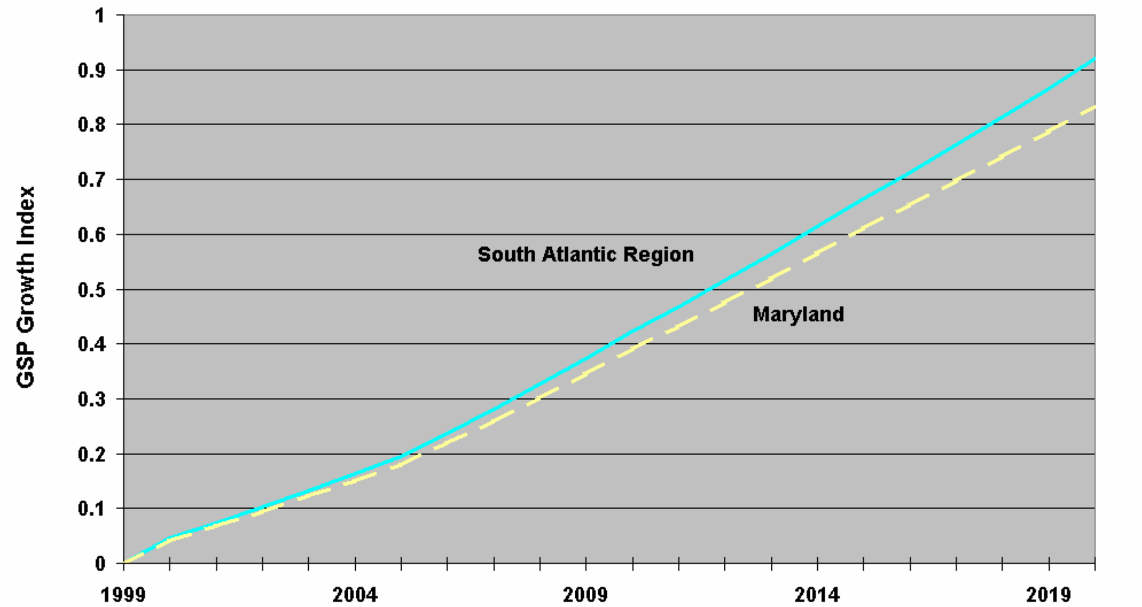
Maryland's Projected GHG Emissions

The National Energy Modeling System (NEMS) was used to forecast the energy use and GHG emissions in Maryland through the year 2020. NEMS is the energy and economic model used by the U.S. Department of Energy's Energy Information Agency (EIA) in developing its Annual Energy Outlook (AEO), which forecasts energy supply, demand, and prices through 2025 (the latest AEO can be found at www.eia.doe.gov/oiaf/aeo). An overview of NEMS along with its documentation can be found at www.eia.doe.gov/oiaf/aeo/overview/overview.html).

NEMS is an extremely data intensive model, accepting and outputting detailed information down to the individual power plant level. It accepts inputs for a wide variety of factors that influence energy consumption and production, including, among others, the price of individual fuels, the growth rate of the economy, tax incentives to promote different technologies, and consumer behavior, and it does so for each census region and division. The census division containing Maryland is the South Atlantic, which also includes Delaware, Washington D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia). The output of NEMS includes energy use by sector and fuel type, and it is possible to extract details such as fuel used at individual power plants.

The disadvantage of NEMS is that its geographic resolution is only as specific as the census division level. This means that minor changes in the NEMS inputs that reflect changes taking place in smaller states like Maryland are difficult to resolve. Therefore, to apply NEMS to the state level and develop and energy and GHG forecast for Maryland, NEMS was first run using the default inputs that EIA uses to produce the national baseline forecast. The relative changes in the outputs (e.g. energy use by fuel type and sector) for the South Atlantic region from the base year (1999) to the forecast years (2000 to 2020) were applied to the base year data for Maryland. In other words, Maryland's 1999 energy data, as supplied by MEA, was assumed to vary in proportion to the South Atlantic region's energy data, as predicted by NEMS. To account for the differences in Maryland relative to the rest of the South Atlantic region, the proportionality factor was in turn based on the relative differences in economic growth, measured by Gross State (or regional) Product, between Maryland and the South Atlantic Region. Figure 3 illustrates the differences in projected economic growth rates in Maryland and the South Atlantic Census Division, which are based on projections of population growth and economic growth per capita.

Figure 3. Gross State Product (GSP) Growth Index for Maryland and the South Atlantic Census Division



Source: SAIC Forecast

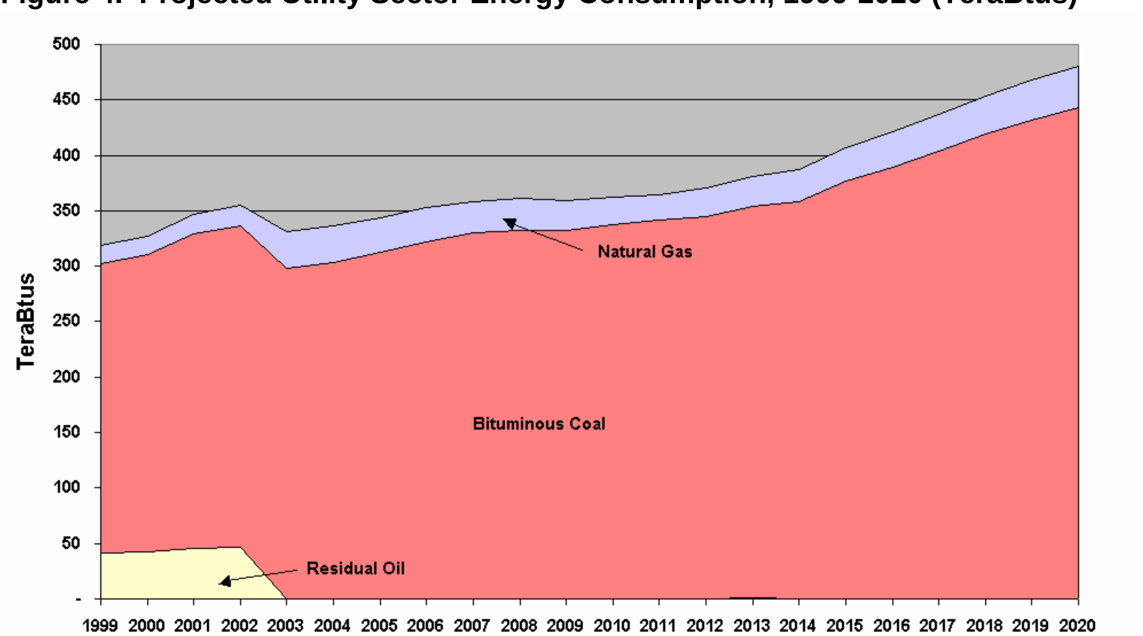
Forecast Results

A separate forecast was developed for each sector, including residential, commercial, transportation, industrial, and utility. The utility sector, which represents the production of electricity that is consumed in each of the other sectors, and therefore has wide ranging implications, is presented below in Figure 4. As the figure illustrates, the dominant fuel is and will continue to be coal, with a phasing out of the use of residual oil and more than a twofold increase in the consumption of natural gas. These sector-specific energy use forecasts were summed and converted into a CO_2 emission forecast, using fuel-specific conversion and oxidation factors.

As Figure 5 illustrates, 76 million tons of carbon dioxide were emitted in Maryland in 1999. CO_2 emissions are projected to increase by 49% by 2020, representing an annual average growth rate of 2.2%. This increase is divided almost equally among the different energy using sectors, as

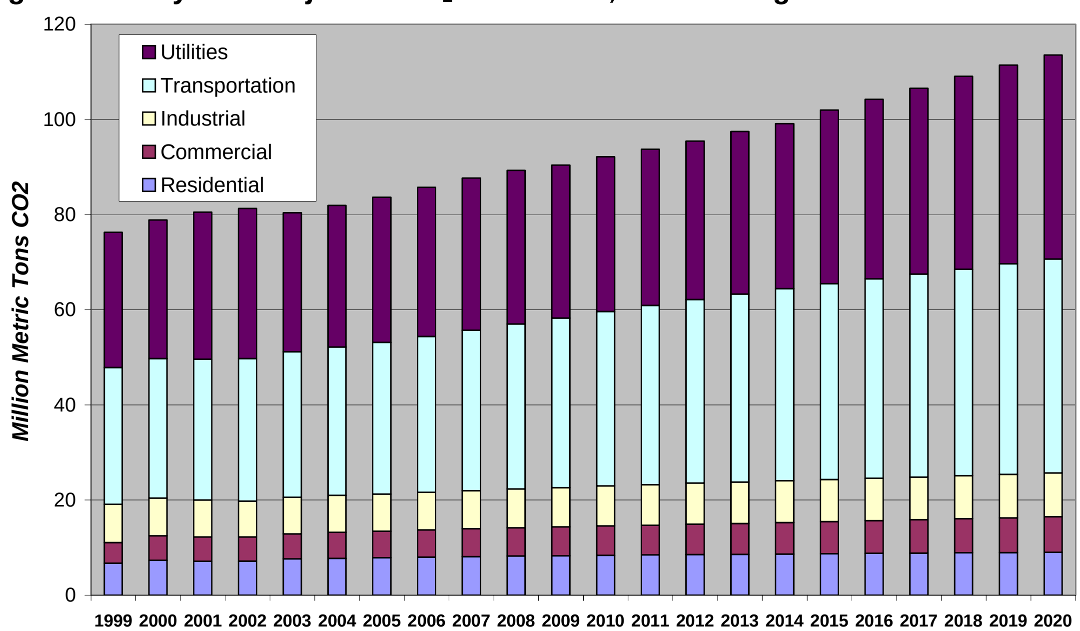
Figure 6 illustrates, with the utility and transportation sectors each maintaining between 35% and 40% share of the total State CO_2 emissions.

Figure 4. Projected Utility Sector Energy Consumption, 1999-2020 (TeraBtus)



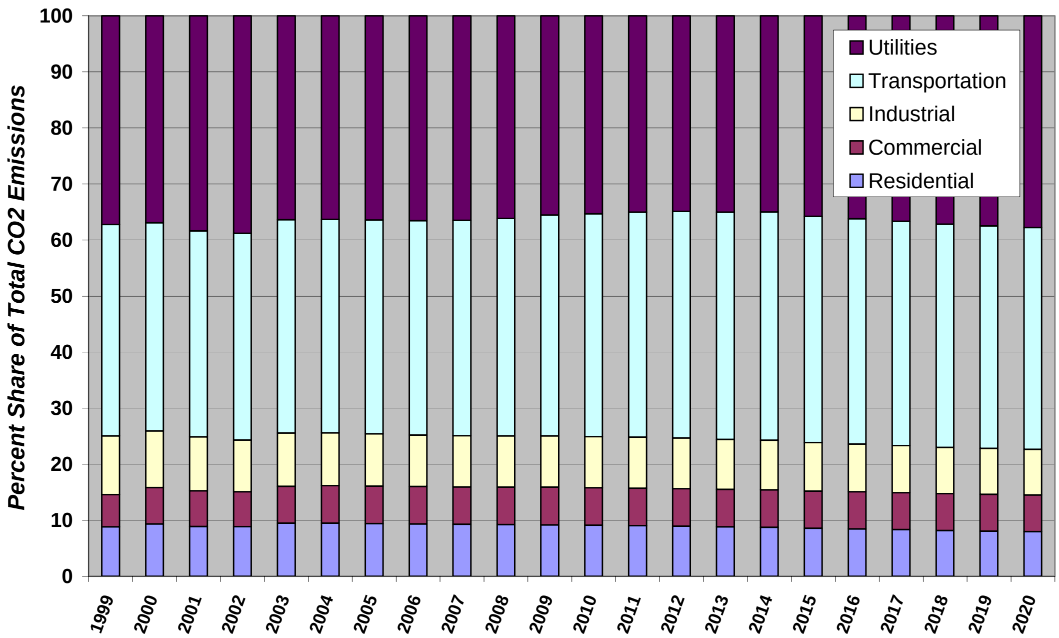
Source: SAIC Forecast

Figure 5. Maryland Projected CO_2 Emissions, 1999 through 2020



Source: SAIC Forecast

Figure 6. % Share of CO_2 Emissions by Economic Sector in Maryland, 1999-2020



Source: SAIC Forecast

i Maryland Department of the Environment, Air And Radiation Management Administration, "Maryland Greenhouse Gas Emissions Inventory, 1990," April 2001.

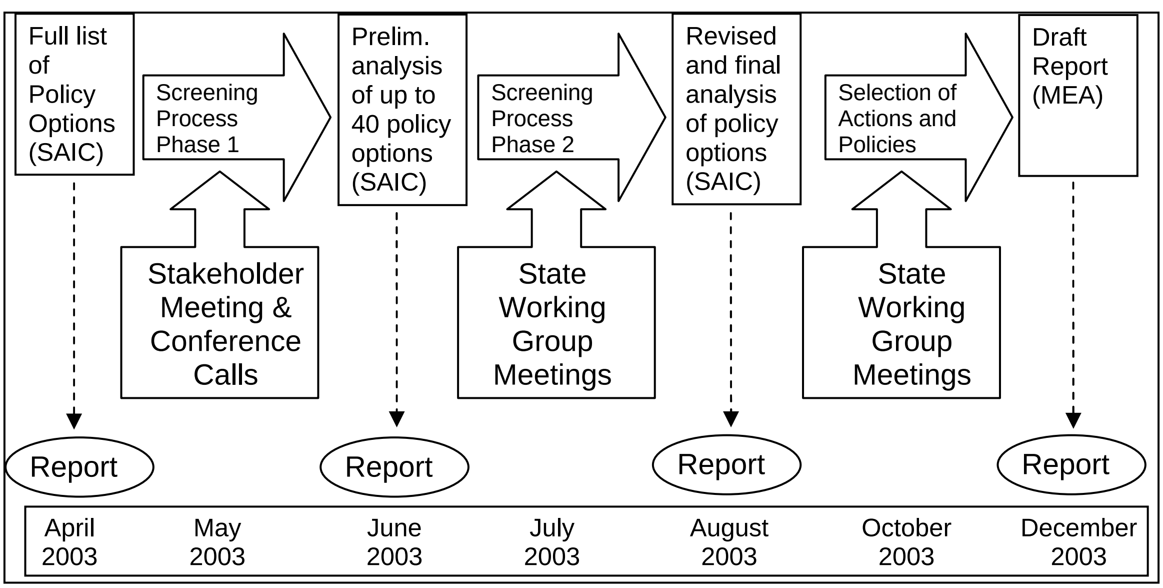
Stakeholder Dialogue

In March of 2003, the Maryland Energy Administration initiated a stakeholder process to help identify potential policies and programs for achieving greenhouse gas emissions reductions. Figure 1 describes the process for stakeholder input. MEA contracted with Science Applications International Corporation (SAIC) to prepare a list of policies and programs in use or suggested for reducing greenhouse gas emissions. To develop this list, SAIC performed a complete review of programs and action plans from other states and supporting documents and recommendations on energy efficiency. This list was distributed to potential stakeholders in advance of a meeting to help spur discussion.

From the outset of the process it was made clear to all participating stakeholders that this was an opportunity to put forward new ideas and comments and make recommendations for voluntary actions to reduce greenhouse gas emissions. The stakeholder process was not created to build a consensus for or against specific ideas but was instead a source of information for the state when identifying potential policies.

Following the one day meeting, held in May 2003, and a series of conference calls organized by economic sector (electricity, agriculture, industry, residential, and commercial), the list of policy options was further refined and discussed by representatives of Maryland state government during the second screening process.

Figure 1. Stakeholder Process



A list of individuals who participated in the stakeholder process is provided below.

NAME	ORGANIZATION	Working Group
Terry Fabian	Allegheny Energy Supply	E
Jason Holstine	Aurum SustainAbility	E, T
Karen Kwiterovich	Baltimore Regional Transportation Board	T
Lily Donge	Calvert Group, Ltd.	E, RCI
Eugene M. Trisko	Center for Energy & Economic Development (CEED)	E, AFW
Terry Cummings	Chesapeake Bay Foundation	AFW
Mike Tidwell	Chesapeake Climate Action Network	E, T
Michael Mallinoff	City of Annapolis	T
Kevin Rackstraw	Clipper Windpower, Inc.	E
Chris Fox	Community College of Baltimore County	T, RCI
Brent Beerley	Community Energy	E
Gary Helm	Conectiv Energy	E
John Quinn	Constellation Energy Group, Inc.	E, T, RCI, AFW
Timothy Matz	Lehigh Cement	RCI
Monica Best James, Esquire	Maryland Chamber of Commerce	E, T, RCI, AFW
Christine Conn	Maryland Department of Natural Resources	AFW
Valerie Connelly	Maryland Farm Bureau	AFW
Lynne Hoot	Maryland Grain Producers Association; Maryland Grain Producers Utilization Board	T, AFW
Michael C. Powell	Maryland Industrial Group	E, RCI
Laura J. Collins	Maryland Interfaith Climate Alliance	RCI
Larry Simms	Maryland Watermen's Association	AFW
David Bonistall	MeadWestvaco	RCI
William Twilley	MeadWestvaco	RCI
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Laura Thomson	Northeast Maryland Waste Disposal Authority	E, AFW

NAME	ORGANIZATION	Working Group
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Mary Quillian	Nuclear Energy Institute	E
Jim Potts	Pepco and Pepco Energy Services	E, RCI
Peter A. Shapiro	Prince George's County Council	RCI, T
Charlie Garlow	Sierra Club, Maryland Chapter	E
Bill Cunningham	Unions for Jobs and the Environment (UJAE)	E
Dr. Reinhard Radermacher	University of Maryland, CEEE	RCI
Julio Friedman	University of Maryland	E, AFW
Byron Davis	UPS	T
Anita Teufel	UPS	T
Edmund Skernolis	Waste Management, Inc.	T, AFW
Gary Fuhrman	Western Maryland Resource Conservation & Development	AFW
Steve Luxenberg	Wilmington Area Planning Council (WILMAPCO)	T