US 40 Carbon Neutral Corridor

FINAL REPORT

final report

U.S. 40 Carbon Neutral Corridor

prepared for

Maryland Department of Transportation &
U.S. 40 CNC Interagency Steering Committee

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Maryland Transportation Authority (MDTA)

Maryland Transit Administration (MTA)

State Highway Administration (SHA)

Baltimore County

Harford County

Maryland Energy Administration (MEA)

Maryland Department of Business and Economic Development (DBED)

University of Maryland National Center for Smart Growth

Maryland Department of General Services (DGS)

Maryland Department of the Environment (MDE)

Maryland Department of Housing and Community Development (DHCD)

Maryland State Department of Education (MSDE)

Maryland Department of Natural Resources (DNR)

Maryland Department of Planning (MDP)

Maryland Department of Agriculture (MDA)

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Executive Summary

The goal of the Carbon Neutral Corridor (CNC) study is to develop a comprehensive corridor vision that integrates land use, conservation, transportation, energy supply and consumption in a fashion that significantly reduces greenhouse gas (GHG) emissions from the corridor across all emission production sectors. The CNC study tests a Maryland specific model to design, implement, measure, and modify new and existing strategies, actions, and off-set programs and policies to significantly reduce carbon emissions. The study helps inform efforts to address the *Greenhouse Gas Emissions Reduction Act of 2009*[1], which has a goal to achieve a 25 percent reduction (from a 2006 baseline) in GHG emissions by 2020 and sustain more significant reductions through 2050. The CNC objectives are also consistent with the Governor's emphasis on *Smart, Green and Growing*[2]and other priority statewide initiatives, including sustainability and preservation of the Chesapeake Bay.

The study was organized and funded by the Maryland Department of Transportation (MDOT) and led in partnership with several State agencies and local planning partners. As part of the study initiation, MDOT formed the Interagency Steering Committee (ISC) to help guide the entire study. Participants in the ISC include MDOT, SHA, MTA, and MDTA, the Department of Agriculture (MDA), the Department of Business and Economic Development (DBED), the Department of Housing and Community Development (DHCD), the Department of Natural Resources (DNR), the Department of the Environment (MDE), the Department of Planning (MDP), the Maryland Energy Administration (MEA), the Department of General Services (DGS), the Department of Education (MSDE), and the University of Maryland National Center for Smart Growth. Following the development of the CNC goals and objectives, the ISC participated in a careful examination of thirteen potential study corridors in Maryland. After a detailed assessment of all thirteen corridors, the US 40 corridor was selected to represent the first pilot corridor to be examined in Maryland. Once the US 40 study corridor was selected as the pilot corridor, the ISC invited Baltimore County and Harford County to participate in the study as ISC members.

The US 40 corridor is characterized by the Chesapeake Bay and adjacent wetlands, Gunpowder Falls State Park, agricultural and forested lands, developed areas in Rosedale/Rossville, White Marsh, Middle River, Joppatowne, Edgewood, Riverside, Perryman, Aberdeen, and Havre de Grace, and is parallel to I-95 and the Amtrak Northeast Corridor/MARC Penn Line. The corridor was selected for its critical location on the Chesapeake Bay, in the Northeast Corridor, and as a BRAC zone (Aberdeen Proving Ground). In addition active interest in contributing to the development of the concept was expressed by both Baltimore and Harford Counties. The corridor's development, land use, transportation, and natural resource diversity allow the lessons learned from the CNC study process to be transferable to other areas in Maryland.

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[1] http://mlis.state.md.us/2009rs/billfile/sb0278.htm

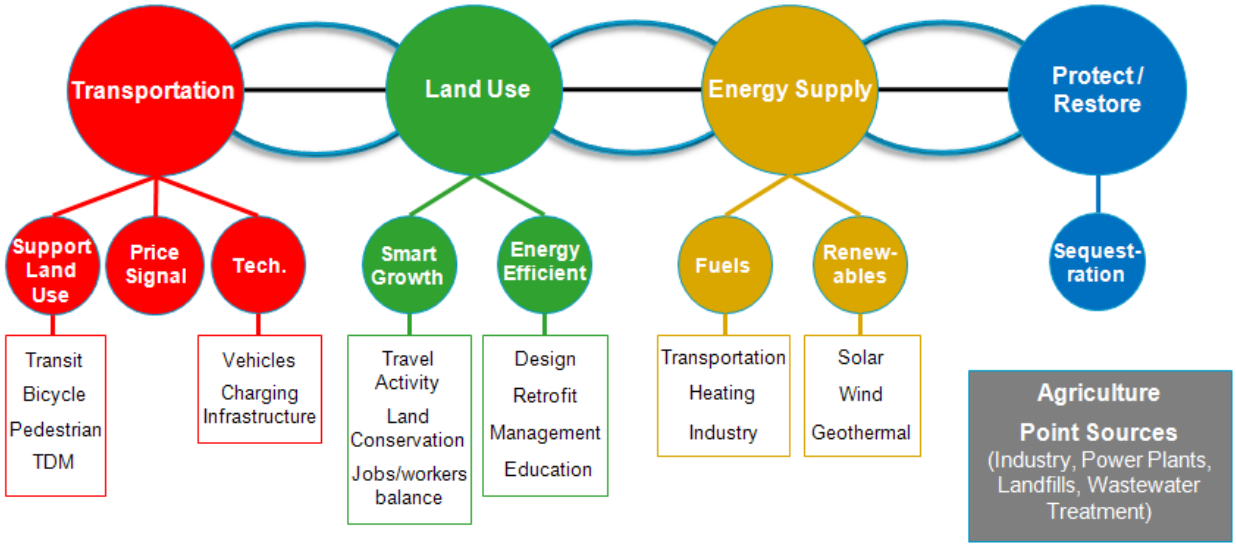
[2] http://www.green.maryland.gov/

A detailed investigation of the corridor transportation system elements, travel patterns, land use, conservation areas, energy consumption, and energy supply trends was completed through 2050. The findings of this initial assessment identified the critical corridor components contributing to existing and future GHG emissions. It also provided the ISC with data and information that could be used to form potential strategies to reduce GHG emissions within the corridor. Based on this information, the ISC organized three independent scenarios, all designed to reduce GHG emissions using different sector-based strategies. The three scenarios were organized around (1) transportation strategies, (2) land use and development strategies, and (3) residential and commercial energy supply and consumption along with land conservation and sequestration activities. The performance of **Scenarios 2 - 4** were compared against the 2006 conditions and the 2035 Baseline (**Scenario 1**).

1. ***Scenario 1 – 2035 Baseline*** – US 40 corridor population and employment growth are consistent with the Baltimore Regional Transportation Board (BRTB) 2010 cooperative population and employment forecasts and planned transportation investment in MDOTs Consolidated Transportation Program, and BRTBs Transportation Improvement Program and Long-Range Transportation Plan (*Transportation Outlook 2035*). Energy consumption and GHG emission rates from other sectors are a subset of the statewide inventory as developed in the *Maryland Climate Action Plan*.
2. ***Scenario 2 – Transportation Activity, Efficiency, and Emissions*** – Expand multimodal transportation infrastructure with supportive programs and policies to encourage use of alternative modes to single-occupant travel. Deploy new system and vehicle technologies, and implement transit oriented development to reduce vehicle miles traveled (VMT) and average on-road vehicle GHG emissions per mile.
3. ***Scenario 3 – Land Use and Development*** – Smart growth and development strategies are focused in town centers with supportive transportation actions and conservation strategies to reduce VMT and preserve natural resource lands that can help sequester carbon.
4. ***Scenario 4 – Energy Consumption, Energy Supply, Land Conservation, and Sequestration*** – Multi-sector energy consumption and supply strategies to reduce GHG emissions per household, per business, and per industry with land conservation and restoration strategies to sequester carbon.

Based on the findings of these scenarios the ISC developed a single comprehensive corridor scenario (**Scenario 5**). **Scenario 5** was organized on the principle of maximizing the GHG savings by identifying the strategies from Scenario's 1 through 4 that provide the greatest benefits through linkages between transportation land use, energy supply and land conservation activities. Figure ES.1 presents the conceptual framework for developing **Scenario 5**.

Figure ES.1 Carbon Neutral Corridor Systems Approach



Scenario 5 was developed with a strong land use concept focusing on "town centers" and included aggressive energy consumption, energy supply, and land conservation strategies along with supportive transportation programs and infrastructure.

Interviews with select corridor stakeholders were conducted to obtain feedback on the CNC concept, the strategies under consideration, and the **Scenario 5** approach. The stakeholders selected for interviews represented a wide range of interests and are leaders in ongoing State and corridor activities that could help shape a low-carbon future for the US 40 corridor and included elected State officials within the corridor, local Chambers of Commerce, the City of Aberdeen, business associations, the Central Maryland Transportation Alliance, community councils and civic associations, major employers (including Franklin Square Hospital, the GM White Marsh Plant, Constellation Energy, and CSX Transportation) and other corridor leadership including representation from Aberdeen Proving Ground. The information collected from the interviews was overall supportive of the CNC concept and was used to inform the development of **Scenario 5**.

Table ES.1 includes a summary of the key elements included in **Scenario 5**.

Table ES.1 U.S. 40 Carbon Neutral Corridor – Scenario 5 Summary

Scenario 5 Component	2035 Strategy Description
U.S. 40 Corridor Town Centers	Refocus planned corridor growth to maximize opportunities to conserve and protect agricultural and natural lands and minimize the proportion of growth occurring outside PFA boundaries. Town center development includes higher densities, mixed residential and commercial uses, a higher share of multi-family and single-family attached housing, opportunities for low and medium income housing, and transit oriented development. The town centers are located in: Rosedale/Rossville, White Marsh, Middle River, Joppatowne, Edgewood, Perryman, and Aberdeen.

Scenario 5 Component	2035 Strategy Description
Corridor Energy Consumption	Energy efficient new construction standards, retrofit and weatherization programs, energy use management strategies for businesses, and appliance and lighting replacement programs.
Industrial, Wastewater, and Landfill Strategies	Create partnerships for pilot industrial sector energy consumption strategies, implement projects to generate useable energy from wastewater treatment and landfill activities.
Corridor Energy Supply	Expand the Renewable Portfolio Standard goal to 2035, deploy solar and geothermal energy programs, and offer incentives for commercial and residential electric vehicle charging infrastructure.
Corridor Conservation Program	Expand parks and protect land in green infrastructure gaps and corridors. Support the reorientation of corridor growth to town centers through deployment of extensive land conservation and protection strategies.
Corridor Restoration and Carbon Sequestration	Implement forest, wetland, riparian buffer, and agricultural restoration programs to mitigate degradation of land and maximize carbon sequestration potential.
MARC Growth and Investment Plan	Improve Penn Line headways, provide reverse commute and off-peak service, improve station access and parking.
U.S. 40 Bus Rapid Transit Corridor	BRT system on U.S. 40 from proposed MARC / MTA Red Line Bayview Station to Aberdeen MARC Station.
I-95 Section 200	Implement by 2035 consistent with current MDTA corridor plan.
CNC - Smart Corridors	Implement consolidated real-time traffic management on all corridor state routes.
Bicycle and Pedestrian Network	Implement a premium off-road bike facility parallel to U.S. 40, implement all trails identified in BRTB LRTP, implement new sidewalks, bike lanes, and signed bike routes connecting town centers and transit.
Transportation Demand Management	Implement corridor-wide comprehensive, consistent, and connected TDM programs.
Transportation Technology	Assume continued implementation of existing and proposed federal fuel economy standards plus a significant share of vehicle miles travelled in zero-emission or electric vehicles.

The results of **Scenario 5** produced significant GHG emission reductions and co-benefits based on an integrated assessment approach that accounts for how land use strategies, land conservation and restoration, energy consumption and supply, and transportation can work together to reduce GHG emissions and overall energy consumption. ***Compared to 2006 corridor emissions, the total corridor GHG emissions in Scenario 5 are reduced by 43 percent in 2035.***

Table ES.2 includes a summary of the total corridor GHG emission reduction results in million metric tons of GHGs annually in 2035 compared to 2006 and the 2035 baseline scenario. The GHG emission benefits of **Scenario 5** can also be summarized by corridor household.

- From transportation activity – In 2035, compared to 2006, 63 pounds of GHG emissions are reduced daily per household as a result of new land use, transportation infrastructure, and vehicle technology strategies (this equals up to 4 gallons of gasoline per household per day)
- From household energy consumption – In 2035, compared to 2006, 37 pounds of GHG emissions are reduced daily per household as a result of new residential energy consumption and supply strategies

Table ES.2 U.S. 40 Carbon Neutral Corridor – 2035 GHG Reduction Summary

GHG Emissions	2006	Baseline (2035)	Scenario 5 (2035)
Total Net Annual Corridor Emissions (mmt GHG)			
Total Net Corridor Emissions	4.24	4.86	2.41
Percent Change From 2006 Total Corridor GHG Emissions			
Total Corridor Transportation Sector GHG Emissions		-20%	-39%
Total Corridor Other Sector GHG Emissions		36%	-34%
Total Corridor Multi-sector GHG Emissions		12%	-36%
Total Corridor Net Multi-sector GHG Emissions		**15%**	**-43%**

Scenario 5 costs and savings were presented through a qualitative view of implementation requirements and cost-effectiveness. The cost-effectiveness results are based on an approach that considers public-sector implementation costs and direct monetary benefits to travelers, homeowners, or business owners in terms of reduced energy consumption.

- Savings from land use and transportation strategies translate to a 32 percent reduction in household energy consumption associated with travel, either through reduced vehicle travel or more energy efficient travel. The combined effect of this reduction in energy use on the cost of owning and operating a vehicle is estimated at $400 annually per household (based on existing fuel costs and vehicle cost data from the American Automobile Association.[3]
- Savings from household based energy consumption strategies result in significant improvements in residential energy efficiency (estimated at a 59 percent reduction per household compared to 2006), leading to reduced electricity demand and household energy cost savings on the order of $800 annually per household (based on current Maryland electricity rates per kwh).[4]

The CNC study highlights the energy benefits that can be realized when implementation actions and plans and agency priorities are aligned around a topic like energy conservation and climate change. Collaboration among state and local partners through existing Maryland designations and programs to support low carbon transportation options, infill development, community redevelopment and revitalization, mixed-income housing opportunities, greenspace preservation, and improved energy efficiency is important to help meet GHG reduction goals. The successful combination of these strategies also has additional benefits to Maryland related to air quality, human health, and the Chesapeake Bay.

[3] Based on American Automobile Association 2011 driving costs publication. http://www.aaaexchange.com/Assets/Files/201145734460.DrivingCosts2011.pdf

[4] Based on average electricity prices per kwh in the Baltimore-Washington area, October 2011 data from the US Department of Labor, Bureau of Labor Statistics. http://www.bls.gov/ro3/apwb.htm

1.0 Introduction

Maryland shares a rich history of preserving its diverse ecosystems while addressing the challenges and opportunities of managing population growth, a diversifying economy, improving infrastructure, preserving the environment, and building sustainable communities. Balancing preservation and environmental stewardship with pressures resulting from economic growth requires a creative approach that integrates Smart Growth, sustainable transportation, energy efficiency, and Smart Conservation.

The carbon neutral corridor (CNC) concept embraces a true multidisciplinary approach to understand methods to address climate change and to provide a wide array of strategies to reduce greenhouse gas (GHG) emissions.

The CNC concept was conceived through a partnership between Cambridge Systematics and The Conservation Fund. Sponsored by the Maryland Department of Transportation (MDOT), the CNC pilot study represents the first Maryland specific approach to bring together an array of stakeholders to test a variety of techniques with a long-term goal of achieving carbon neutrality. In a CNC, transportation carbon emissions are reduced and the remainder offset to the point where over the long term, the multi-sector net carbon emissions from the corridor are significantly reduced. Strategies will range from transportation measures/technologies combined with carbon sequestration off-sets from aforestation and reforestation to working with local businesses on work force patterns to implementing educational programs on sustainable land use planning.

1.1 The Goal of the Carbon Neutral Corridor Concept

The goal of the CNC is to: through a strategic coalition building process, develop a comprehensive corridor vision that results in attaining smart growth, conservation, transportation and climate change goals where the net emissions from the corridor are significantly reduced.

Since achieving "carbon neutrality" is an ambitious goal, corridor strategies, actions and policies are considered in phases – a reduced carbon footprint in the near term, minimal footprint in the mid-term, and approaching a zero footprint in the long term. Based on the intense focus on the long-term sustainability of Maryland, the CNC concept provides Maryland a real-world application of the themes and policies included under the *Smart, Green and Growing* umbrella.

1.2 Why Consider a Carbon Neutral Corridor?

The CNC concept and goals were translated into the following set of program objectives which helped guide the study process, interaction with a multidisciplinary group of State and local agencies (the Interagency Steering Committee), and development and assessment of scenarios.

The CNC concept:

- Creates a real world setting that can serve as a model to design, implement, measure, and modify new and existing strategies, actions, and off-set programs that significantly reduce carbon emissions;
- Provides the ability to build broad coalitions of both traditional and nontraditional transportation partners by gauging and measuring the acceptance of strategies and leveraging actions that reduce GHG emissions;
- Provides the opportunity to understand and document the institutional issues associated with a multiagency and multidisciplinary initiatives;
- Documents the co-benefits, including sustainable infrastructure investments, increasing energy efficiency and strategic conservation programs;
- Supports the activities associated with development of the *Maryland Climate Action Plan*[5];
- Informs efforts to address the *Greenhouse Gas Emissions Reduction Act of 2009* which has a goal to achieve a 25 percent reduction (from 2006) in GHG emissions by 2020 and sustain more significant reductions through 2050;
- Remains consistent with the Governor's emphasis on *Smart, Green and Growing* and priority initiatives, including sustainability; and
- Puts Maryland in a clear National leadership role in studying and implementing Climate Change demonstration programs.

1.3 CARBON NEUTRAL CORRIDOR STUDY OVERVIEW

The first phase of the pilot study, as presented in this report, focused on reducing carbon emissions below 2006 levels by 2035, which defines a mid-term goal for achieving carbon neutrality. The study views 2020 as a short-term goal and details corridor strategies that can be implemented by 2020 – however the focus of the emissions analysis is 2035 (the longer term view to 2035 allows for a better accounting of the benefit of land use strategies). The study focuses on all measures to reduce carbon emissions, including land use and development, transportation, energy consumption and supply, and natural land conservation and carbon sequestration.

The study process was initiated with the development of the CNC goals and objectives. The corridor selection process included two phases – Phase 1 included the selection of five corridors from an initial screening list of 13 corridors in Maryland, Phase 2 conducted a detailed assessment of the five corridors, reaching consensus on the selection of U.S. 40 as the pilot CNC.

Development of the U.S. 40 CNC was initiated through establishing an in depth understanding of current and projected transportation, economic, environmental, and energy consumption

[5] http://www.mde.state.md.us/Pages/Home.aspx

conditions and unique attributes of the corridor. This included an extensive quantitative analysis of corridor trends across all economic activities.

MDOT convened a core team of MDOT staff and representatives from the Maryland Transit Administration (MTA), the State Highway Administration (SHA) and the Maryland Transportation Authority (MDTA) to support the corridor selection process. A multidisciplinary group of State and local agency representatives, the Interagency Steering Committee (ISC), was also convened to provide overall strategic direction and consulting support for the entire work program, and to help build support for the CNC project and the pilot corridor. State agencies on the ISC ultimately represent the partners that will lead the future implementation of the corridor vision.

The Interagency Steering Committee includes agencies external to MDOT such as Maryland Department of the Environment (MDE), Maryland Department of Planning (MDP), Department of Housing and Community Development (DHCD), Maryland Energy Administration (MEA), Department of Natural Resources (DNR), Department of Business and Economic Development (DBED), Maryland Department of Agriculture (MDA), Maryland State Department of Education (MSDE), and the National Center for Smart Growth Research and Education at the University of Maryland (UMD) (refer to Appendix A for the full member list). The role of the Interagency Steering Committee is to serve as a partner to MDOT to support the overall CNC vision, to engage individual agency partners not typically involved in transportation planning, to provide agency-specific input and review, and to provide consulting support for the entire work program.

The core team and Interagency Steering Committee (ISC) discussed the results of the trends assessment and identified key corridor transportation, land use and energy elements that affect greenhouse gas emissions. These elements supported the development of three alternative corridor scenarios, representing independent approaches to reducing greenhouse gases. Each scenario was assessed across a variety of performance measures and emission measures to assess the relative benefit of each at the corridor, household, and business level for reducing energy consumption and GHG emissions. The review by the core team and the ISC served as the starting point for developing a multi-sector comprehensive CNC scenario (referred to as Scenario 5).

To confirm the objectives of the CNC concept as well as the Scenario 5 approach, 13 interviews were conducted with corridor stakeholders. The stakeholders represented a diverse set of interests and are leaders in ongoing corridor activities that will help shape the future of a low-carbon future for U.S. 40 (the full stakeholder list is documented in Appendix I). This wide range of interests including advocacy groups, local chambers of commerce, business associations, community councils, major employers (including Franklin Square Hospital, the GM White Marsh Plant, Constellation Energy, and CSX Transportation) and other corridor leadership including representation from Aberdeen Proving Ground and the Chesapeake Science and Security Corridor.

Scenario 5 combined elements from the three alternative corridor scenarios to maximize emission reductions through a multi-sector suite of strategies. The outcomes of the analysis of Scenario 5 indicate corridor GHG emissions reductions of 43 percent compared to 2006 conditions in 2035. In addition the presentation of Scenario 5 identified other implementation

elements and considerations such as cost-effectiveness, indirect and co-benefits, implementation barriers, and implementation partnerships.

The organization of the report is as follows:

- **Section 2.0 – Pilot Carbon Neutral Corridor Selection –** Presents a summary of the corridor selection process;
- **Section 3.0 – U.S. 40 Corridor Context and Trends –** Summarizes the Baseline trends in the U.S. 40 corridor through 2050;
- **Section 4.0 – U.S. 40 Carbon Neutral Corridor Development Process –** Summarizes the content of scenario testing, outcomes of corridor stakeholder outreach, and development of Scenario 5;
- **Section 5.0 – U.S. 40 Carbon Neutral Corridor "Scenario 5" Multi-sector Approach and Results** – Details Scenario 5 components, results and implementation considerations;
- **Section 6.0 – U.S. 40 Carbon Neutral Corridor Partnerships –** Identifies the importance of partnerships to successful implementation; and
- **Section 7.0 – Carbon Neutral Corridor Key Summary Findings –** Provides a synthesis of the lessons learned during the study.

2.0 Pilot Carbon Neutral Corridor Selection

2.1 Pilot Corridor Selection Process

Consistent with ongoing initiatives in Maryland including *Smart, Green, and Growing*, MDOT in partnership with other State agencies piloted the carbon neutral corridor (CNC) concept. The pilot concept focuses on a multidisciplinary approach to plan and evaluate policies, programs and actions to address energy efficiency and reduce GHG emissions.

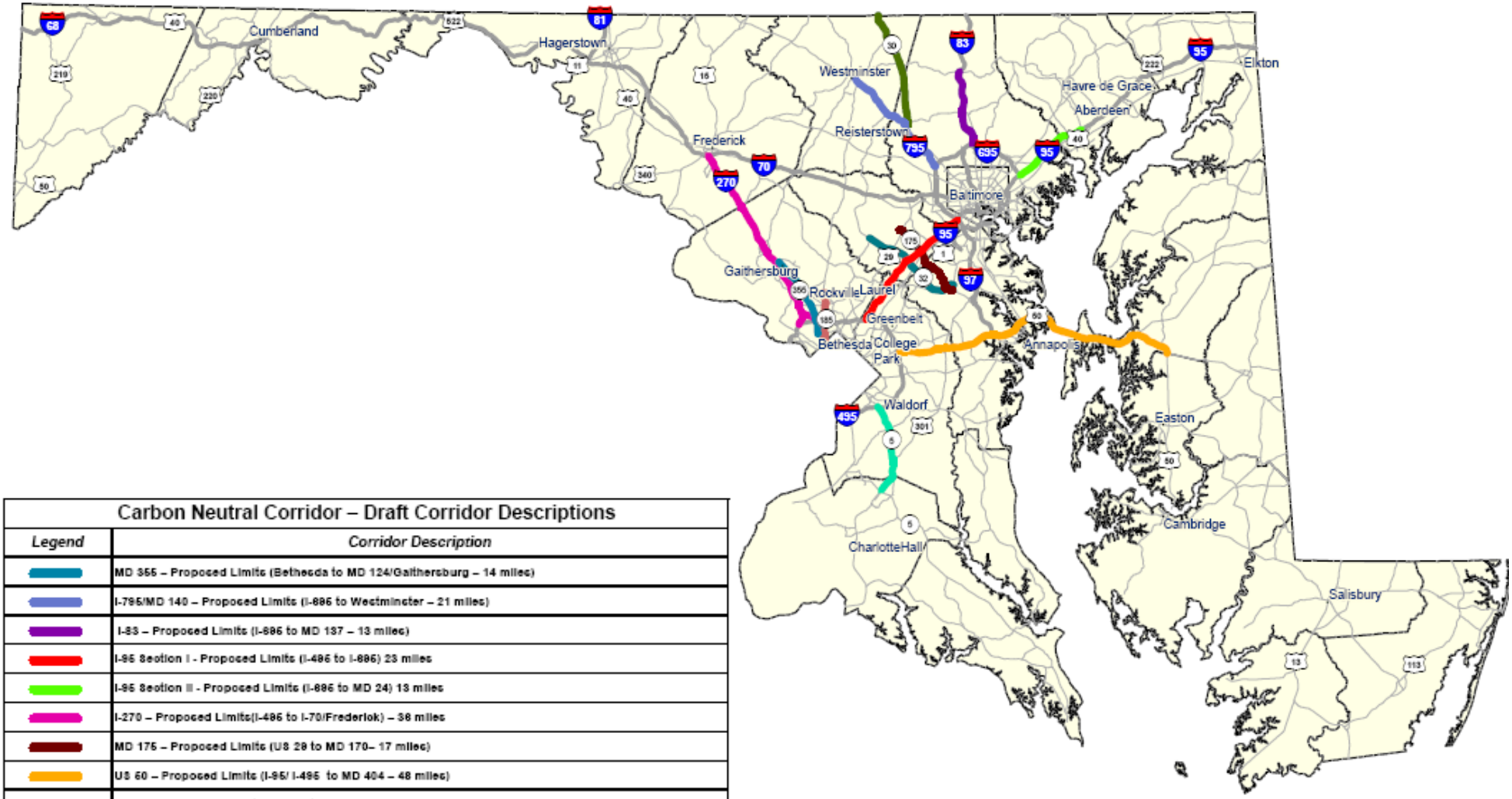
The concept of a CNC is based on the premise that within a well-defined and distinct geographic transportation corridor combinations of transportation, land use, energy, and environmental protection and conservation strategies will result in a long-term decrease in GHG emissions. The concept is analogous to reducing the carbon "footprint" of a particular industry or area by employing all strategies available. The corridor(s) considered for the CNC pilot include a diverse mix of transportation facilities, types of land use, levels of and rates of growth, while being amenable to active involvement in identifying new and innovative sustainable practices for improving the environment, the economy, and the overall quality of life. A readiness factor and/or willingness to engage in such visioning exercises and other necessary outreach activities are a criterion that is given substantial consideration in the corridor selection process.

The selection of the pilot corridor was the critical first step to ensuring long-term and wide-ranging benefits of the CNC concept. The goal of the selection process is to identify a corridor with a diverse transportation system, economy and environment so that the project process and findings would have transferability to other areas in Maryland.

Initial Corridor Screening Process

The first task of the corridor selection process was designed to screen 13 potential corridors identified by the core MDOT team to a constrained list for more detailed evaluation. The initial list of corridors was developed internally through consultation with the MDOT modal agencies. The initial list of corridors are presented in Figure 2.1.

Figure 2.1 Initial Carbon Neutral Corridors



Carbon Neutral Corridor – Draft Corridor Descriptions	
Legend	*Corridor Description*
	MD 355 – Proposed Limits (Bethesda to MD 124/Gaithersburg – 14 miles)
	I-795/MD 140 – Proposed Limits (I-695 to Westminster – 21 miles)
	I-83 – Proposed Limits (I-695 to MD 137 – 13 miles)
	I-95 Section I - Proposed Limits (I-495 to I-695) 23 miles
	I-95 Section II - Proposed Limits (I-695 to MD 24) 13 miles
	I-270 – Proposed Limits(I-495 to I-70/Frederick) – 38 miles
	MD 175 – Proposed Limits (US 29 to MD 170– 17 miles)
	US 50 – Proposed Limits (I-95/ I-495 to MD 404 – 48 miles)
	MD 185 - Proposed Limits (MD 97 to MD/DC Line – 9 miles)
	MD 30 – Proposed Limits (Maryland State Line to I-795/Reisterstown – 18 miles)
	MD 32 - Proposed Limits (MD 108 to MD 170 - 17 miles)
	MD 5 – Proposed Limits (I-95/I-495 to White Plains – 16 miles)

After further consideration, the core team decided that the two segments of I-95 originally identified should be shifted to U.S. 1 (I-495 to I-195) and U.S. 40 (I-95 to Havre de Grace). Ongoing evaluation of traffic operations and greenhouse gas reductions strategies and policies on I-95 are being considered by the I-95 Corridor Coalition.[6] Shifting to U.S. 1 and U.S. 40 increases the relevance of strategies focusing on local development and transportation issues.

The overall corridor selection process is presented in Figure 2.2. The initial corridor screening process focused on four emphasis areas: modal mix, land use and development, manageability, and transferability.

Modal Mix – Corridors with existing or proposed transit networks reflect potential for reducing carbon emissions from transportation through mode shifts from more carbon intensive modes and associated transit-oriented development opportunities.

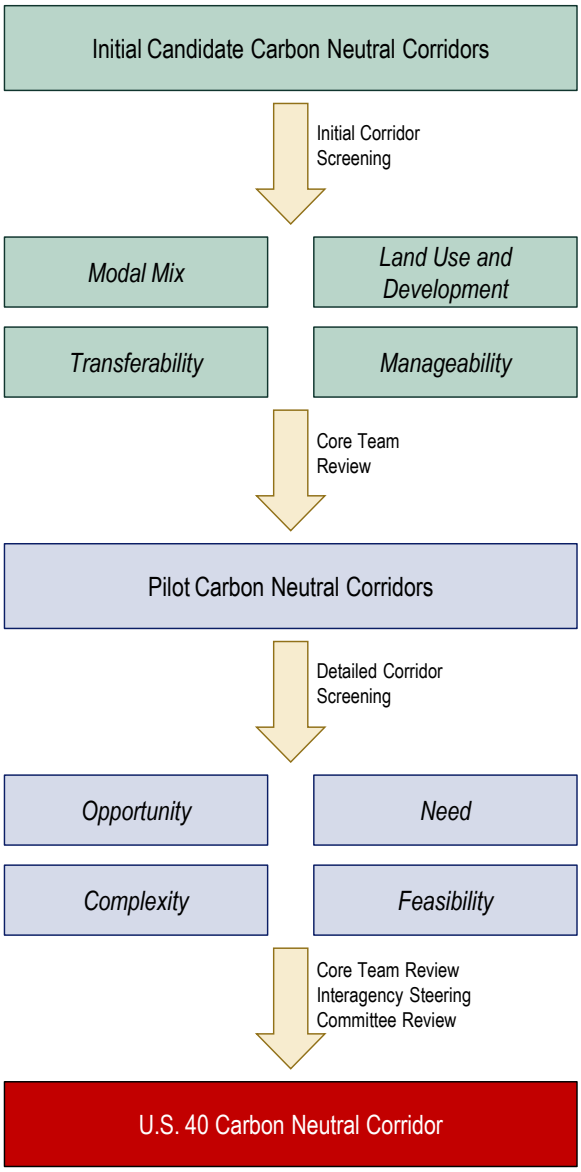
Land Use and Development – Corridors with a greater diversity of land uses and growth opportunities reflect potential for reducing carbon emissions from transportation through both mode shift to transit or biking and walking, or reduced vehicle trip lengths. Corridors with a higher share of undeveloped or protected lands have a higher potential for implementing strategies to sequester carbon.

Manageability – Corridors that lend themselves to clear definitions of logical geographic and political boundaries are expected to present less significant challenges to managing resources to complete the project, conduct corridor outreach activities and ultimately implement GHG reduction strategies.

Transferability – The study process and corridor plan should be transferable to other potential CNC's within priority growth areas in Maryland.

While all the corridors considered have merit as candidates for a CNC study in the future, the initial screening focused on ease of implementing a pilot demonstration study.

Figure 2.2 Corridor Selection Process



[6] http://www.i95coalition.org/i95/Default.aspx.

Using the criteria and screening mechanisms identified in Table 2.1, a combined qualitative and quantitative assessment of the 13 corridors was developed.

Appendix B presents the results of this screening and the logic supporting the identification of the final five corridors.

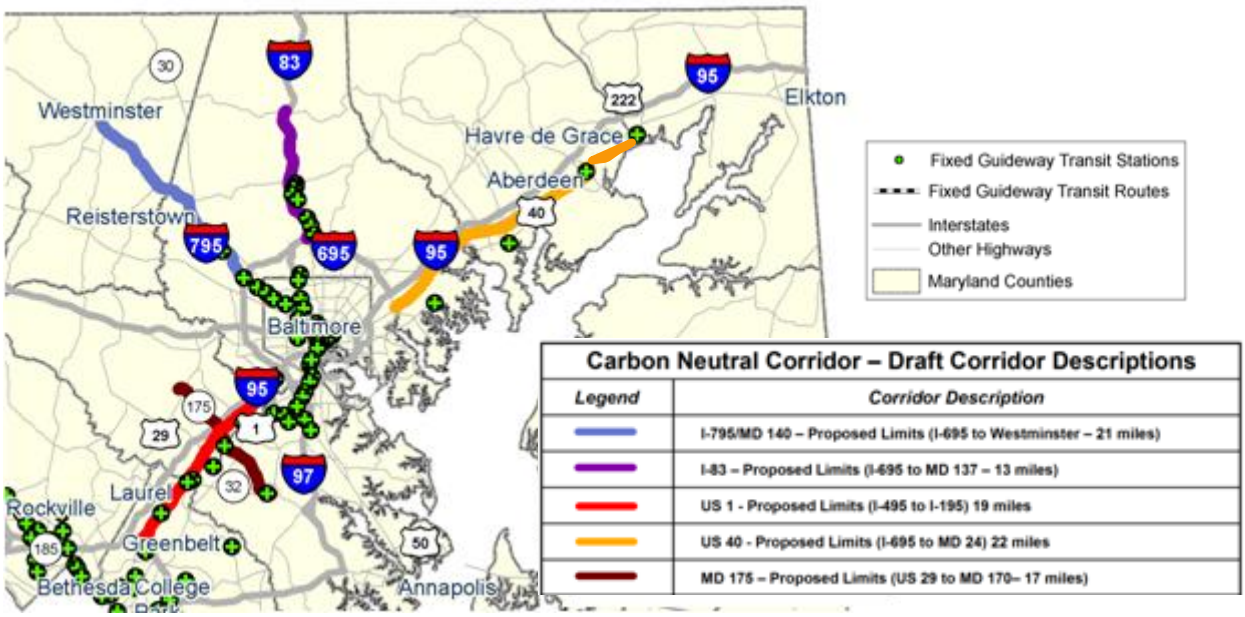
Table 2.1 Initial Corridor Screening Criteria

	Criteria	Screening Mechanism
Modal Mix	Modal mix – existing and planned transit service.	0 – No transit service. 1 – Transit service limited to bus only. 2 – Fixed-guideway and bus transit service.
Land Use and Development	Land use mix along with the level and intensity of growth – existing and planned.	0 – Corridor with limited PFAs. 1 – Corridor with PFAs and planned growth.
	Mix and complexity of the natural environment.	Level and type of forest and agricultural land within the corridor per green infrastructure map.
Manageability	Ability to define logical geographic/political boundaries.	Number of governmental units in the corridor.
Transferability	Transferability of strategies to other areas and corridors.	0 – Not consistent with growth areas in MD. 1 – Partly consistent with growth areas in MD. 2 – Consistent with growth areas in MD.

Detailed Corridor Screening

While all corridors provide unique opportunities, the core team selected five corridors for more detailed screening based on the above criteria. The objective of the detailed corridor screening is to identify distinguishing characteristics that might set one or more corridors apart in consideration for the CNC pilot study. The five corridors are presented in Figure 2.3.

Figure 2.3 Five Candidate Carbon Neutral Corridors



The five corridors were reviewed based on the data developed in Table 2.2 organized across an assessment of four decision factors. The decision factors ultimately guided the selection of the project corridor.

- **Opportunity –** Potential for mode shift, Smart Growth and carbon sequestration from conservation and restoration strategies;
- **Need –** Impacts of corridor population and employment growth on transportation system level of service, preservation of natural lands and energy consumption;
- **Complexity –** Interaction of travel and development patterns, cross-jurisdiction relationships, and level of conflict across trip types and modes; and
- **Feasibility –** Is carbon neutrality an attainable goal for the corridor based on existing sources of GHGs.

Table 2.2 Corridor Ranking Criteria

1.	Modal mix	7.	Consistency with other MDOT initiatives
2.	Consistency and logic of travel in the corridor	8.	Ability to define logical geographic/political boundaries
3.	Transferability of strategies to other areas and corridors	9.	Public and private support
4.	Land use mix along with the level and intensity of growth	10.	Freight activity within the corridor
5.	Potential funding partners	11.	Availability of supporting data
6.	Mix and complexity of the natural environment	12.	Qualitative assessment of the GHG reduction potential

The five corridors all met the goals and objectives of the CNC concept and represented viable options for the project. Based on the analysis, the critical distinguishing criteria included: consistency and logic of travel, land use mix and level of growth, mix and complexity of the natural environment, ability to define logical boundaries and freight activity. The quantitative analysis was augmented by input from both the core team and Interagency Steering Committee. Their input reflected opportunities for State- and local-level partnerships as well as the level of public and private support of the CNC concept.

The results of the corridor analysis are included in Appendix C. The results are associated with existing and future conditions within a five-mile corridor buffer area. The data sources included transportation-specific data from MDOT and MPOs, land use and development data from MPOs and Maryland Department of Planning, and conservation-related data from the Maryland *GreenPrint*[7] database (refer to maps included in Appendix D).

The selection of the pilot CNC was based on the findings within the assessment of corridor opportunity, need, feasibility and complexity balanced with a consideration of local support. Corridor opportunity and need were considered in terms of the level of balance across the three primary discipline areas within the CNC concept (transportation, land use/development, and conservation). For complexity, pilot corridor manageability in terms of stakeholder

[7] http://www.greenprint.maryland.gov/

participation and travel market complexities hindering GHG emission reductions were considered. For feasibility the anticipated level of corridor strategy transferability as well as input from the core team and Interagency Steering Committee on the anticipated level of public and private support within the corridor were the key deciding factors.

Detailed Screening Results

The five corridors all have significant merits for consideration as a pilot CNC. Based on the corridor analysis included in Appendix C, along with input from the core team and Interagency Steering Committee, two corridors stand out – U.S. 40 and I-795/MD 140.

The core team and interagency steering committee recommended U.S. 40, from the Baltimore City line to Havre de Grace, as the CNC pilot demonstration project. The key aspects of the U.S. 40 corridor supporting its selection as the pilot corridor are noted below:

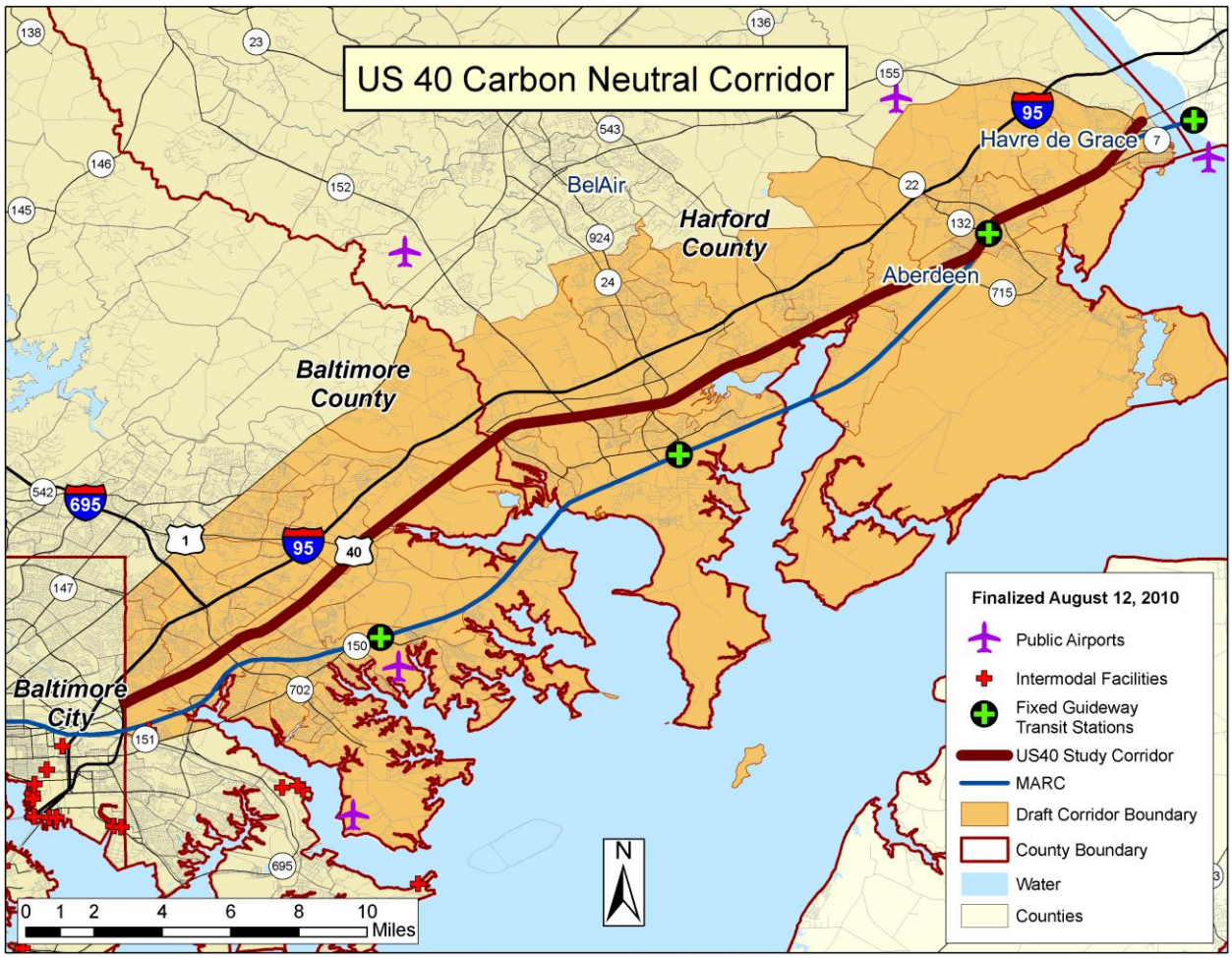
- The existing land uses in the corridor represent a cross-section of Maryland – including established urban neighborhoods and aging commercial strip development, new suburban development, distribution centers, transit-oriented development, and agricultural and natural lands.
- The U.S. 40 corridor shows opportunity for mode shift from single-occupant vehicle trips to multiple corridor transit services, particularly due to growth associated with BRAC activities at Aberdeen Proving Ground (APG).
- The corridor rates high for sequestration opportunities due to natural land uses, particularly adjacent to the Chesapeake Bay, in addition to aggressive policies for rural and agricultural land preservation in Baltimore and Harford Counties and protection and restoration of the Chesapeake Bay watershed.
- Ongoing improvements to I-95 in Baltimore County, combined with long-range planned improvements for the extent of I-95 to Cecil County and the MARC Penn Line will improve overall corridor travel conditions, establish an express toll lane system to help address corridor delay, and improve level of service on commuter rail and bus service.
- Baltimore and Harford County's reflect similar goals for redevelopment and transportation investment in the U.S. 40 corridor in their master plans and ongoing related planning and implementation studies and efforts.
- The corridor has ongoing planning and economic development efforts including APG BRAC, Aberdeen Transit-Oriented Development, the Chesapeake Science and Security Corridor (CSSC), and the Baltimore County led *Pulaski Highway Redevelopment Study*.

U.S. 40 CNC/Pilot Corridor Location Map

The corridor boundary is designed to incorporate multiple elements that all will be key aspects to developing strategies and scenarios for the U.S. 40 CNC. These elements include: geographical and political boundaries, census tract boundaries, existing and future multimodal transportation infrastructure, existing and planned land uses and development, agricultural and conservation/preservation areas, and industrial areas.

The boundary considered an overlay of these multiple layers as well as an investigation of aerial photography and knowledge of corridor conditions and travel characteristics. Figure 2.4 presents the study area boundary. A specific description of the corridor study area is included below.

Figure 2.4 U.S. 40 Carbon Neutral Corridor Study Area



U.S. 40 CNC Study Area – Baltimore County

South and East of U.S. 40:

- U.S. 40 intersects I-95 just inside the Baltimore City limits. The south end of the corridor includes this interchange.
- South of U.S. 40 the boundary runs along the City limits to MD 151 (North Point Boulevard) and runs along MD 150 including the Back River Wastewater Treatment Plant. East of the Back River, the boundary incorporates all of Essex including Essex Skypark Airport and Rocky Point Park. This entire area was included due to the presence of existing parkland and conservation opportunities.

- The boundary includes the remainder of Baltimore County's shoreline up to the Harford County line, including Martin State Airport and MARC Station, Edgewood Arsenal, Baltimore County Eastern Landfill, Constellation Energy's C.P. Crane coal fired power plant and Gunpowder Falls State Park.

North and West of U.S. 40:

- From the U.S. 40 interchange with I-95, the corridor boundary follows the Baltimore City limits north to U.S. 1 (3.1 miles north of U.S. 40).
- The boundary follows U.S. 1 to the Harford County line. This area includes White Marsh and Perry Hall as well as Resource Preservation Areas and Rural Residential Areas outside of Baltimore County's Urban Rural Demarcation Line (URDL).

U.S. 40 CNC Study Area – Harford County

South and East of U.S. 40:

- The boundary follows Harford County's shoreline from the Baltimore County line to the Susquehanna River/Cecil County line. This area includes the CSX freight corridor and Amtrak Northeast Corridor/MARC Penn line (including Edgewood and Aberdeen stations), Aberdeen Proving Ground, and the cities of Aberdeen and Havre de Grace.

North and West of U.S. 40:

- The boundary from the Baltimore County line follows census tract boundaries on a line approximately halfway between I-95 and U.S. 1/MD 22. The actual boundary is less precise in order to have flexibility in including potential conservation and agricultural areas in Harford County. The boundary remains south of U.S. 1 and MD 22 so as to not include the City of Bel Air. The corridor boundary picks up MD 155, including the Harford County Airport and intersects with I-95.

3.0 U.S. 40 Corridor Context and Trends

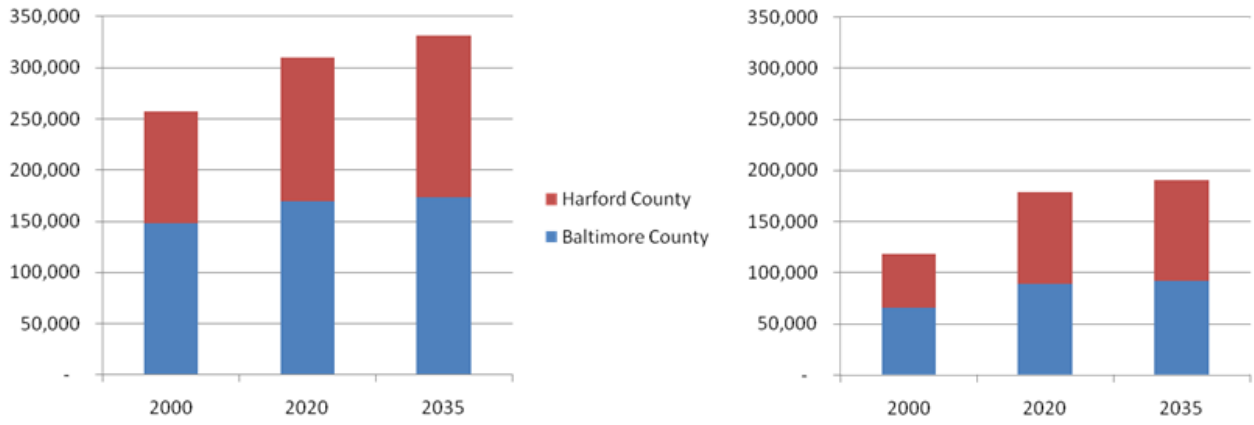
To initiate the process of developing alternative transportation, land use, conservation and energy scenarios for the U.S. 40 corridor, recent and future trends were assessed. To assess trends, data from the Baltimore Regional Transportation Board (BRTB), U.S. Census, Baltimore and Harford Counties, and MDOT was used. This includes population, household, and employment projections through 2035 developed cooperatively between BMC and the counties for use in development of the long-range regional transportation plan.

As a result of available data, particularly forecast data, the trends assessment included data for 2000 and 2035. This section presents the results of the corridor trends assessed separately and the cumulative GHG emissions results in the corridor in 2006, 2020, and 2035. Emission forecasts in 2050 are based on extending the 2020 to 2035 trend.

3.1 U.S. 40 Population and Employment

According to the 2000 U.S. Census, the U.S. 40 corridor included just over 250,000 residents and 115,000 jobs (2010 Census statistics were not available at the time of development of corridor trends). Forecasts cooperatively developed by BRTB, Baltimore County, and Harford County in 2010, show that population grows by 1 percent annually through 2020, and 0.5 percent annually 2020 to 2035. Employment grows by 2 percent annually through 2020, and 0.4 percent annually 2020 to 2035 (see Figures 3.1 and 3.2). The BRAC activity at Aberdeen Proving Ground (APG) supports the acceleration of both the population and employment growth in the corridor (Figure 3.2). High-growth areas are forecast along and adjacent to U.S. 40, along MD 24, and the city of Bel Air.

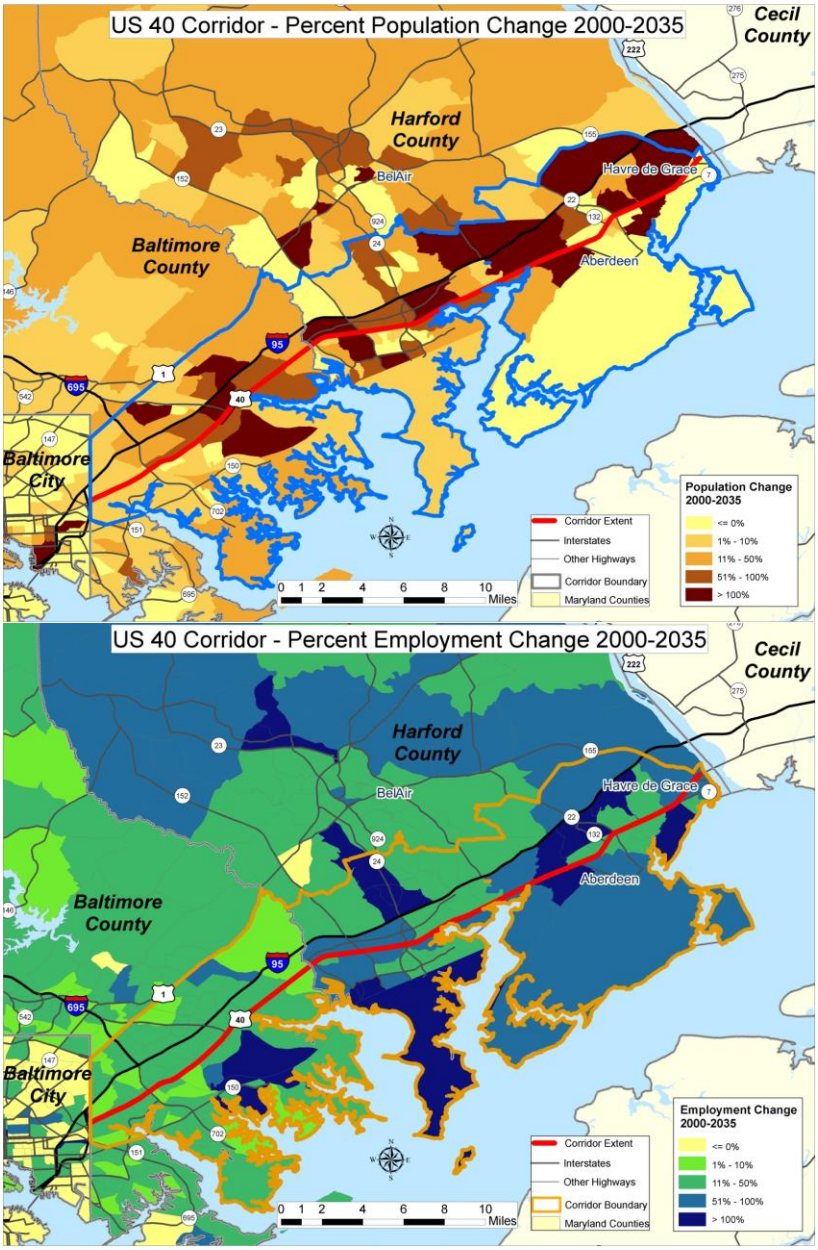
Figure 3.1 U.S. 40 Corridor Population and Employment Growth Trend and Forecasts



Both Baltimore County and Harford County have recently completed or are in the process of completing comprehensive land use plans to effectively address this anticipated growth. Several key growth statistics that guided the development of alternative CNC scenarios are summarized below.

- Greater than 97 percent of growth is forecast to occur in priority funding areas.[8]
- Job growth outpaces household and workforce growth (2 to 1).
- Corridor jobs to workers ratio increases from 0.9 in 2000 to 1.2 by 2035, meaning that jobs are increasing faster than the available workforce in the corridor.
- The share of employment in the office sector in the corridor increases, but is still less than the average Baltimore regional share by 2035 (45 percent region, 40 percent corridor).
- The most significant population growth occurs in areas adjacent to I-95 interchanges, and in areas between Aberdeen and Havre de Grace.
- The most significant jobs growth occurs in Harford County, particularly at Aberdeen Proving Ground, in Aberdeen, and along the MD 24 corridor.

Figure 3.2 U.S. 40 Corridor Percent Growth *2000-2035*

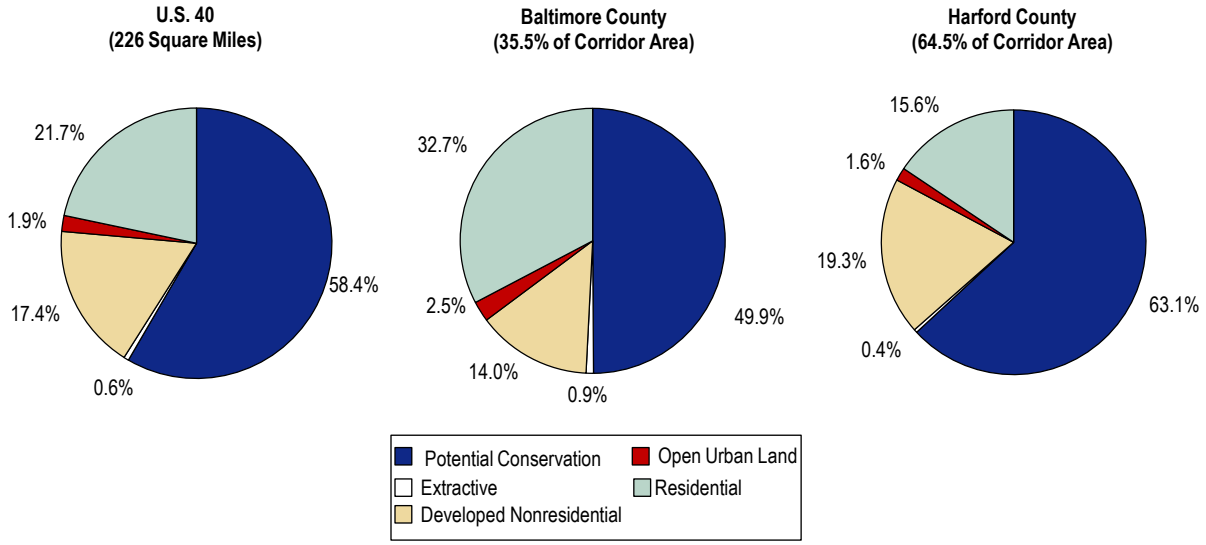


[8] Priority Funding Areas are growth areas delineated cooperatively by the Maryland Department of Planning and the counties to reflect where infrastructure resources should be focused. See: http://www.mdp.state.md.us/OurProducts/pfamap.shtml for more details.

3.2 U.S. 40 Land Use and Development

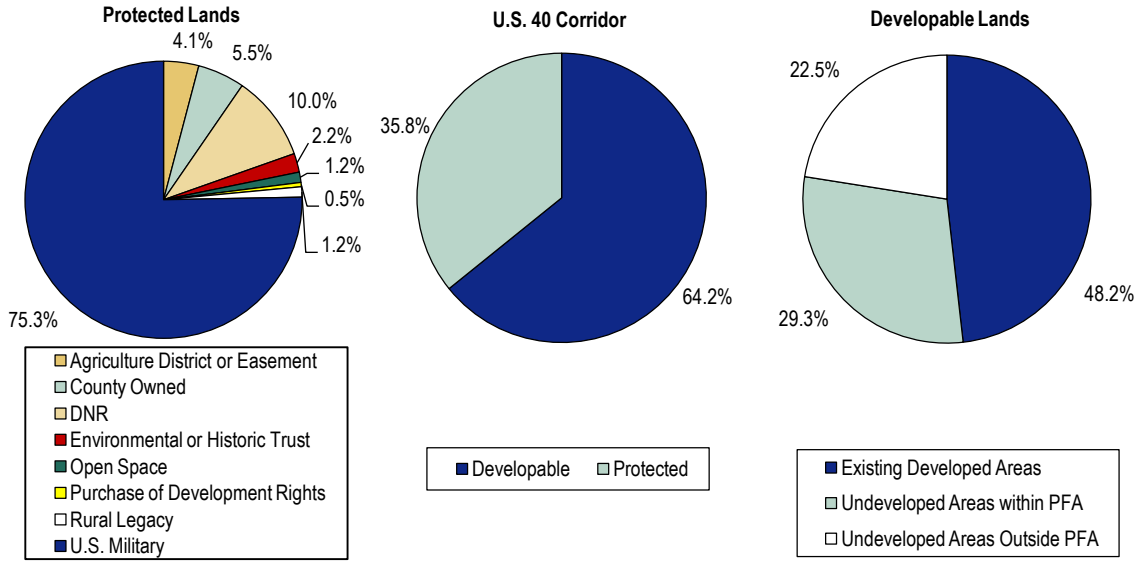
Based on the Maryland Department of Planning 2002 land use data, 58 percent of the 226-square-mile U.S. 40 corridor study area is characterized as a potential conservation area (forest, pastures, wetlands, or agriculture). The remaining land uses are split between residential (22 percent), commercial (18 percent), and undeveloped/vacant urban land (2 percent) (refer to Figure 3.3).

Figure 3.3 Existing U.S. 40 Corridor Land Use



Much of the growth in the corridor is anticipated to occur in the potential conservation areas that could reduce the carbon sequestration capacity of the corridor. Figure 3.4 presents the protection status of these areas.

Figure 3.4 Protected Versus Developable Lands in the U.S. 40 Corridor



Key summary items associated with the existing land use and forecast of land development within the corridor include the following items.

- Sixty-four percent of the corridor land area is defined as developable (APG is defined as protected in this analysis). Of these developable areas, 48 percent is already within existing PFAs and 29 percent are in undeveloped areas within PFAs.
- Redevelopment opportunities are being planned or are underway within the corridor. They include the Baltimore County *Pulaski Highway Redevelopment Study*[9] and the *Aberdeen MARC Station Transit-Oriented Development*[10].
- *GrowthPrint*[11] areas in the U.S. 40 corridor highlight areas within Priority Funding Areas (PFAs) that are currently being targeted for infill, revitalization and redevelopment (see Figure 3.5). Maryland's *Sustainable Communities*[12] are the primary target areas. Sustainable Communities in the U.S. 40 corridor include Community Legacy Areas, Designated Neighborhoods, BRAC Zones and the Aberdeen TOD area. Other State programs that are included in GrowthPrint are Maryland's Main Streets, Maple Streets, Enterprise Zones and Targeted Investment Zones (TIZ) within Maryland Heritage Areas. As noted in Figure 3.5, significant portions of the U.S. 40 corridor, and roughly 75 percent of land directly on U.S. 40 is classified as targeted area for redevelopment (GrowthPrint) or as a PFA.
- The majority of protected lands in the corridor are owned by the U.S. Government. It is estimated that 50 to 60 percent of APGs land area is currently forested or wetlands. New development at APG is anticipated to only minimally impact the protected land.

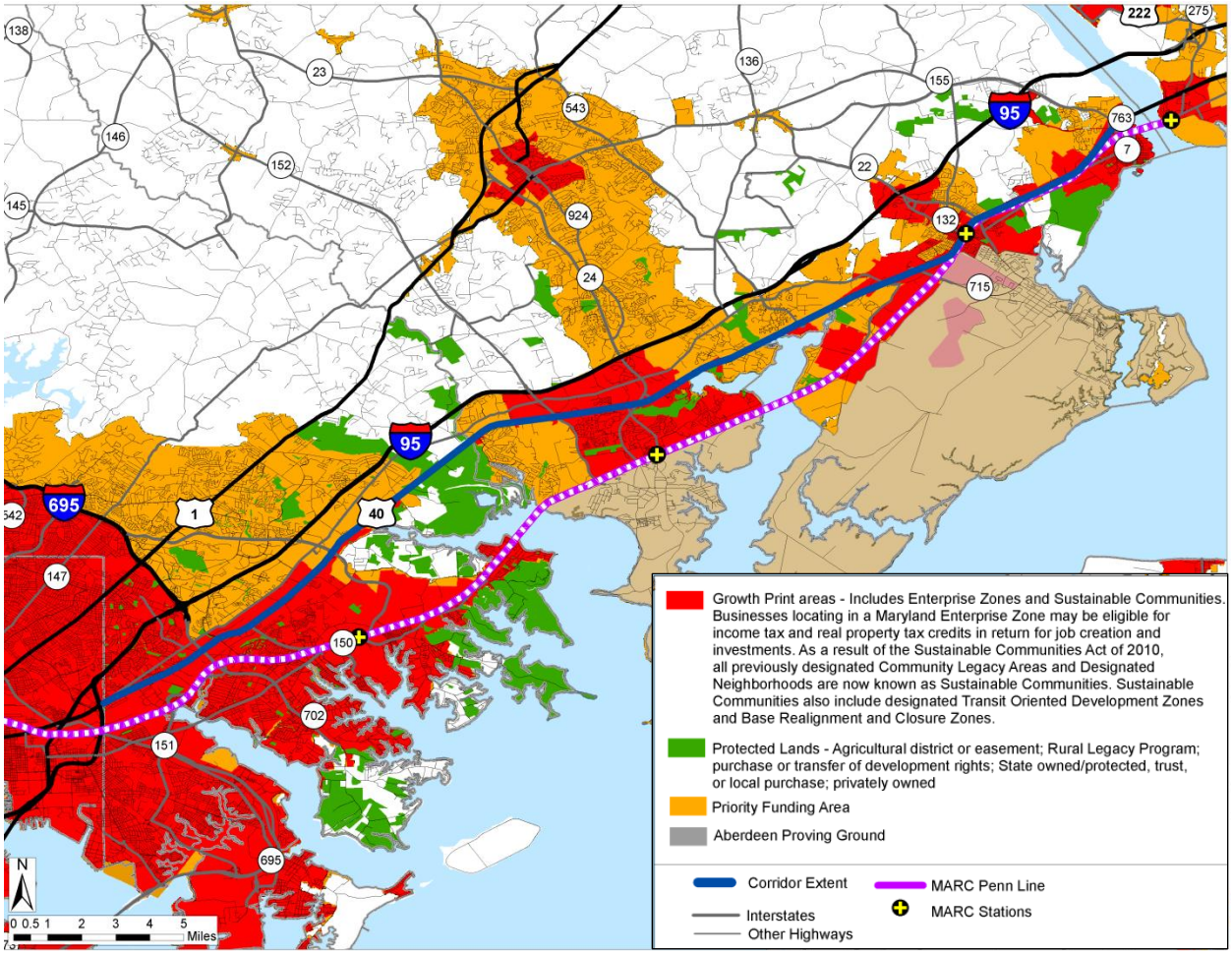
[9] http://www.baltimorecountymd.gov/Agencies/planning/Pulaski%20Highway/index.html

[10] http://www.mdot.maryland.gov/Planning/TOD/Aberdeen_TOD.html

[11] http://www.growthprint.maryland.gov/

[12] http://www.mdhousing.org/website/programs/dn/default.aspx

Figure 3.5 U.S. 40 Corridor Redevelopment and Revitalization Areas



3.3 U.S. 40 TRANSPORTATION ACTIVITY

Both I-95 and the Amtrak Northeast Corridor have a strong influence on travel in the U.S. 40 corridor. The majority of regional and interstate person and freight trips occur on I-95 and the parallel CSX and Norfolk Southern rail routes. In 2008, I-95 (south of the interchange with MD 24) shows an average daily traffic of almost 160,000 vehicles, with over 11 percent of these trucks. At the same point on U.S. 40, average daily traffic on U.S. 40 is 53,000 vehicles with 6 percent trucks. U.S. 40 acts as a local commuting route providing access to Baltimore and at times provides relieve to travel on I-95. The corridor also features the MARC Penn Line providing commuter rail access to Baltimore and Washington, D.C., multiple MTA Commuter Bus routes serving the Baltimore CBD, and local transit services in Baltimore and Harford County.

A description of the existing and planned future transportation assets in the corridor is included in Appendix E.

Changes in population and employment growth (discussed above) directly affect the forecast of trip-making. Table 3.1 reflects that the share of all trips within the corridor is increasing while trips elsewhere in Baltimore and Harford County as well as Baltimore City are decreasing. It is interesting to note that the share of trips from elsewhere in Maryland, while modest, also increase as a result of the enhanced job opportunities in the corridor (the majority of these trips are from Cecil County). Total daily corridor trips that start or end in the corridor increase by 39 percent from 2000 to 2035.

Table 3.2 presents the transit mode share in the U.S. 40 corridor in 2000 and 2035. As highlighted in Table 3.2, the percentage of work trips using transit actually drops over the 35-year period. In fact, the percentage of work trips using transit as the primary mode drop by 25 percent over the 35-year period.

Table 3.1 U.S. 40 Corridor Person Trip Patterns

Corridor Person Trip Locations	2000	2035
Trips within Corridor	64.5%	67.1%
Rest of Baltimore and Harford County	18.6%	16.7%
Baltimore City	11.2%	9.0%
Rest of Maryland	5.6%	7.2%
Corridor Total Daily Person Trips (1,000s)	**1,247.0**	**1,734.2**

Table 3.2 U.S. 40 Corridor Transit Mode Shares

Transit Mode Share	2000	2035
Work Trips	**5.5%**	**4.7%**
Within Corridor	2.4%	1.8%
Baltimore and Harford County	3.6%	4.0%
Baltimore City	12.4%	13.2%
All Other Trips	**< 0.5%**	**< 0.6%**
School Trips	**1.9%**	**1.6%**

Total trips and mode shares affect total vehicle miles of travel (VMT) and congestion within the corridor. As evidenced from data from the Baltimore Regional Transportation Board's (BRTB) regional travel demand model, the changes in travel activity and network performance from 2000 to 2035 are significant:

- Corridor VMT grows 56 percent from 2000 to 2035, with an annual VMT growth rate 2000 to 2020 of 1.5 percent and a post-2020 annual VMT growth rate of 1.0 percent;
- Congested VMT during the a.m. and p.m. periods increase from 30 percent in 2000 to 56 percent in 2035;
- Eighty percent of the congested VMT in the corridor occurs on I-95/I-695 in 2000 – decreasing to 77 percent in 2035; and
- The largest percent growth in congested VMT occurs on principal arterials – a result of the growth in internal corridor trips.

3.4 U.S. 40 Residential and Commercial Energy Consumption and Supply

Electricity consumption in the U.S. 40 corridor increases at a slower rate than population and employment growth. The relationship reflects the anticipated benefits of the *EmPOWER Maryland* program, which establishes reduction in energy consumption (15 percent reduction in consumption by 2015) and identifies actions and programs to reduce consumption. These programs include both residential and commercial programs:

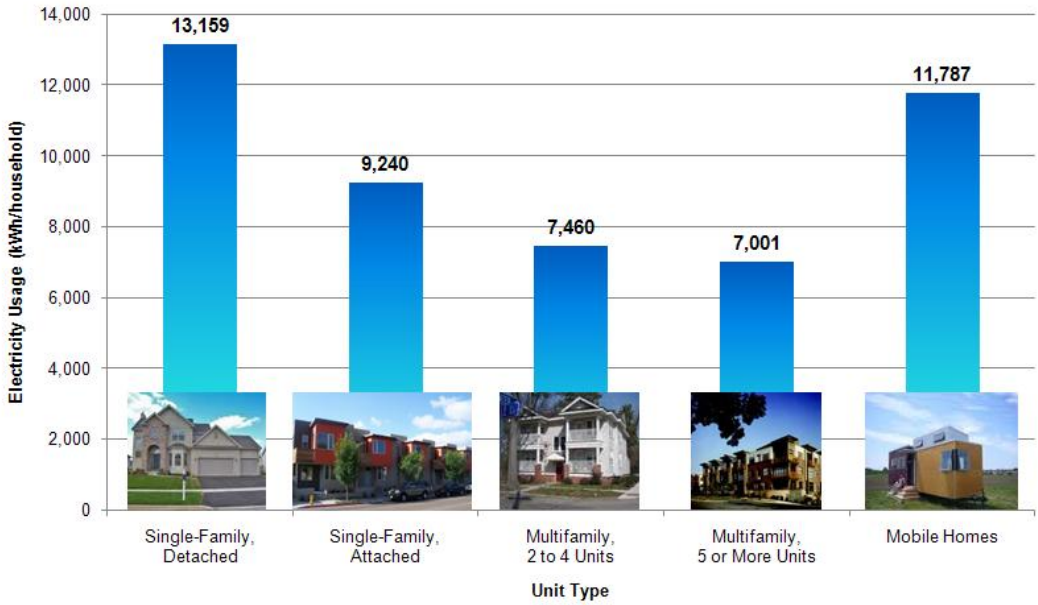
- **Residential –** Energy Efficient Appliance Rebates, Single and Multifamily Homes Efficiency Retrofits, Clean Energy Financing, Clean Energy Job Training; and
- **Industrial/Commercial –** Energy Efficiency Low-Interest Loans, Energy Assessments.

The Renewable Portfolio Standard (RPS) – establishes a target for the renewable sources of electricity along with incentives for homeowners and businesses to invest in clean energy technology. These program elements include the following elements:

- Requires 20 percent of Maryland's electricity be generated from renewable sources by 2022, including 2 percent from solar energy and
- Initiatives to encourage installation at the consumer level and utility level.

A critical factor in assessing residential energy consumption in the corridor is based on the portfolio of existing and future housing types. As described in Figure 3.6, average electricity usage for single-family attached housing is 30 percent less than single-family detached, and 43 percent less for multifamily housing. Change in corridor housing type from 1990 to 2000 resulted in virtually no change in the corridor average annual household energy consumption.

Figure 3.6 Average Electricity Usage by Household Type



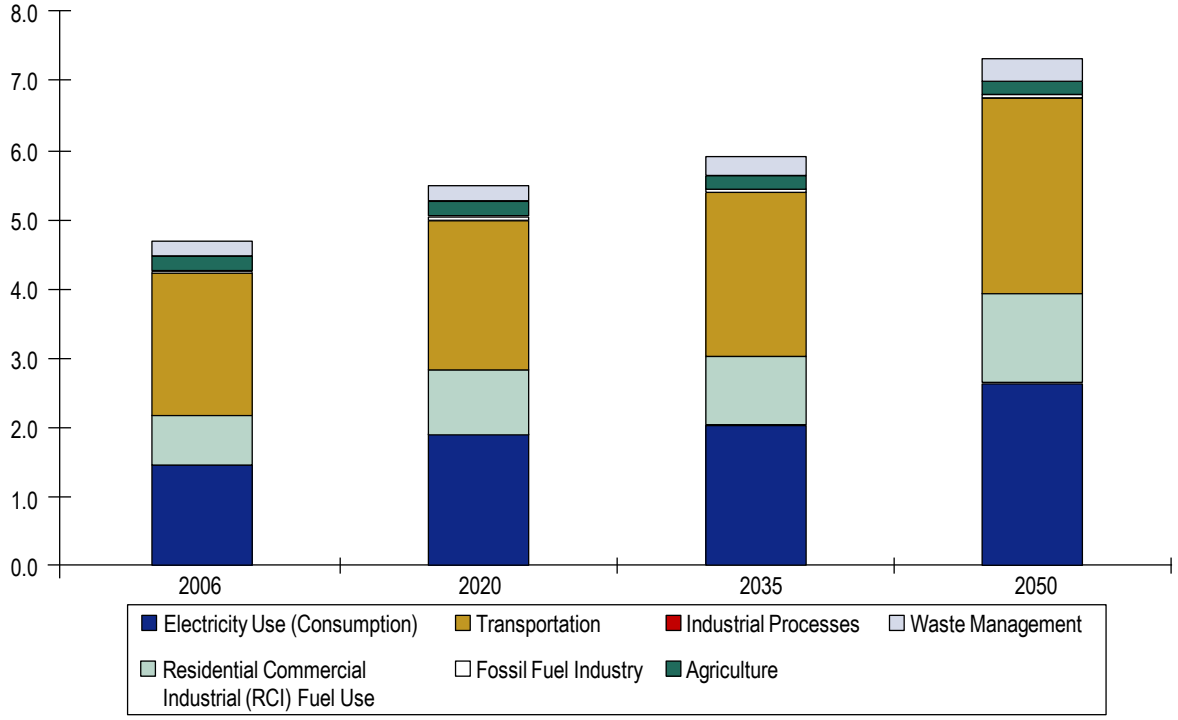
Source: Energy Information Administration. 2005 Residential Energy Consumption Survey. Table US8.

3.5 U.S. 40 Corridor Greenhouse Gas Emissions

The combination of population and employment growth, changes in land use, trends in travel activity, and rates of energy consumption all affect changes in the U.S. 40 corridor overall carbon footprint. Figure 3.7 presents total corridor GHG emissions by sector. The figure indicates consistent growth in total corridor emissions, while the contribution of GHG emissions by individual sector does change relative to the other sectors over time.

In 2006, the U.S. 40 corridor represents 4.5 percent of the statewide GHG emissions inventory. Compared to the statewide figures, within the corridor, the transportation sector plays a more significant role in total GHG emissions (44 percent compared to 31 percent statewide). This is not a surprising conclusion given the magnitude of passenger and freight movement in the corridor compared to the overall corridor population and economic activity. Through 2035, the share from transportation is expected to decrease to around 38 percent (partially as a result of new Federal 2012 to 2016 vehicle fuel economy standards and the projected increase in miles traveled by electric vehicles). Additional trend analysis and emission results are presented in Appendix F.

Figure 3.7 U.S. 40 Corridor GHG Emissions Summary
million metric tons (mmt) GHG



From 2006 to 2050, Figure 3.6 indicates a 60 percent growth in total corridor GHG emissions. This is attributable to a growing population and associated travel activity that exceeds per vehicle mile transportation technology and fuel improvements, and reductions in rates of household and commercial energy consumption.

3.6 SUMMARY OF THE CORRIDOR TRENDS ANALYSIS

The trend assessment was summarized into land use, transportation, and energy outcomes that provided the basis to organize the scenarios that are documented in the following section. In partnership with the ISC the following set of items were noted.

Land Use and Development

- Population and employment growth – Take full advantage of Smart Growth planning concepts for new and redevelopment opportunities and focus growth in PFAs.
- Consumption of greenspace and agricultural lands – Fully deploy existing conservation programs, implement new programs and restore natural land uses to help sequester carbon.

Transportation

- Largest single sector contributor to GHG emissions in the corridor – Transportation strategies should balance needs for addressing growth in regional travel and intracorridor travel.
- VMT growth places additional pressure on arterials – Address growing congestion on arterials through management and operations strategies and strategic capacity.
- Declining share of transit use within corridor – Develop multimodal travel options to address growth in short-distance corridor trips.
- BRAC focused employment and population growth at and adjacent to Aberdeen Proving Ground – Implement transit services and commuter programs to offer multiple travel options to APG.
- VMT growth results in increased GHG emissions – Aggressively pursue incentives and purchasing strategies for low-carbon vehicle and fuel technologies and infrastructure to support electric vehicle use.

Energy Consumption and Supply

- Growing population in corridor – Implement energy efficiency standards for all new construction, offer incentive programs to encourage retrofits, and adjust zoning as needed to support broader development of single-family attached and multifamily housing.
- Growing employment opportunities – Implement programs to educate and support aggressive low-carbon business operation practices.
- Special generators in the corridor – Expand renewable energy technologies that optimize the efficiency of waste treatment and industrial activities.

4.0 U.S. 40 Carbon Neutral Corridor Development Process

Based on the summary of corridor trends the Interagency Steering Committee (ISC) met on four separate occasions to:

1. Review corridor trends and discuss guiding elements of corridor scenarios;
2. Refine corridor scenario objectives and develop corridor definitions;
3. Review corridor scenario testing results and discuss options for a comprehensive scenario; and
4. Review the comprehensive scenario definitions and assess scenario testing results.

This section summarizes the process associated with the development and testing of the initial four carbon neutral corridor (CNC) scenarios. A subsequent section will address the comprehensive CNC scenario.

4.1 Technical Approach and Performance Measures

The study team employed a detailed technical assessment process for the initial scenario analysis. The study team utilized the BRTB travel demand forecasting model and emissions model to assess the benefits and impacts of transportation and land use elements of the scenarios. The BRTBs socioeconomic data projections were used as the starting point for each scenario.[13] Based on the scenario elements modifications to the BRTB socioeconomic forecast were made to best capture scenario elements.

For transportation measures not accounted for in the travel model, the study team used Transportation Emission Reduction Measures (TERM) methodologies also employed by the BRTB. For non-transportation scenario elements, off-model tools were employed using readily available data and information specific to Maryland and the study corridor. These off-model tools were designed through consultation with the Maryland Energy Administration (MEA), and through researching of methods consistent with the Maryland Climate Action Plan.

A series of performance measures were defined and used for the initial scenario assessment. They include the following items.

- Transportation system changes including VMT, delay, transit trips, and mode share;
- Energy consumption rates by travel activity, household, industry sector;

[13] Baltimore Metropolitan Council, 2010 Round 7-C Cooperative Forecasts.

- Total land preservation, carbon sequestration potential, co-benefits of best management practices; and
- GHG emissions – reported in million metric tons (mmt).

A voluminous amount of technical information was developed to understand the benefits and impacts of each scenario. The summary of that information and methodology sources are included in Appendix H.

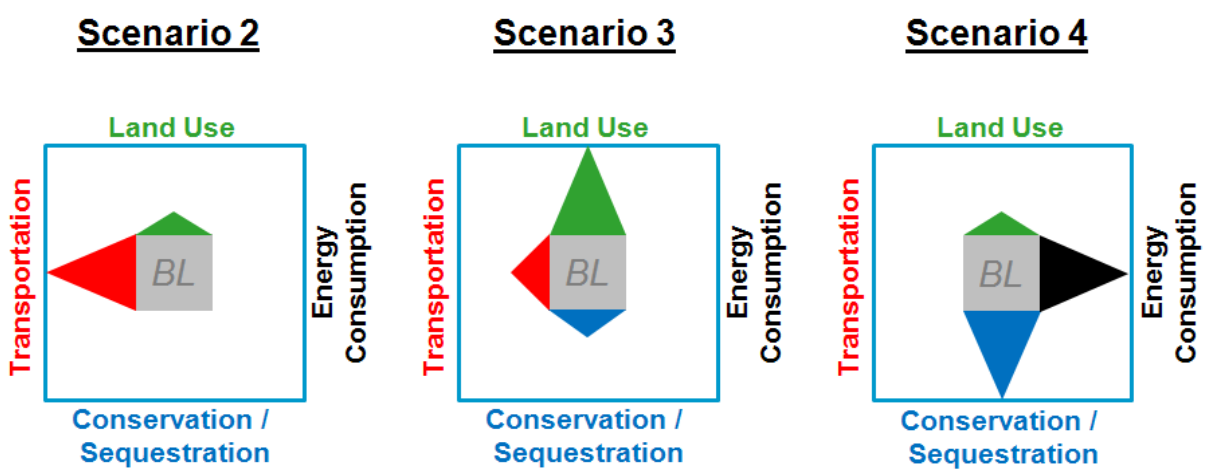
4.2 INITIAL CNC SCENARIO DEFINITIONS AND KEY SUMMARY RESULTS

The corridor scenarios are comprised of transportation, land use, conservation, and energy efficiency strategies. The initial set of strategies, actions, and policies were designed to provide:

- A comprehensive assessment of the possible transportation, conservation, and land use-related strategies designed to reduce GHG emissions in the U.S. 40 corridor;
- Consistency with strategies included in the ongoing development of the Maryland Climate Action Plan; and
- State and corridor support for the overall CNC vision and the GHG reduction strategies identified for the corridor.

As highlighted in Figure 4.1, the initial scenarios were developed to establish a predominate emphasis area. This was done intentionally to isolate and understand the unique benefits of 1) transportation projects, programs and policies, 2) land use and development, 3) land conservation, carbon sequestration; and 4) energy consumption/supply strategies. More detailed descriptions of Scenario 1-4 are provided in Appendix G.

Figure 4.1 Scenario Focus Areas



Note: The Baseline Scenario (Scenario 1) is designated BL.

Scenario 1 – 2035 Baseline

Scenarios 2 - 4 were tested and compared against the 2035 Baseline assessment (Scenario 1) – to provide a common basis for comparison. The Baseline is the same scenario as presented in the trends analysis in Chapter 3, and reflects the State, region, and local jurisdiction current population and employment forecasts and planned investments in the corridor.

Summary Results

The results are based on a comparison to 2006, consistent with the base year for the Greenhouse Gas Reduction Act. The BRTB travel model and associated socioeconomic data were used to produce transportation sector summary results for 2035. Other non-transportation analysis tools are consistent with MDE approaches in the *Maryland Climate Action Plan* and MEA approaches in the *Maryland Energy Outlook*[14].

- Based on the 2035 BRTB forecast, corridor population increases 29 percent, and corridor employment increases 61 percent from 2006 to 2035;
- This growth translates to a 56 percent increase in total corridor daily vehicle miles traveled, and an increase in average daily VMT per household from 47.7 to 51.6 miles per day;
- However, due to deployment of existing and proposed vehicle technology and fuel programs, total corridor mobile source GHG emissions will decrease from 1.92 mmt in 2006, to 1.53mmt in 2035[15];
- New household construction practices, energy efficiency programs, and increased use of renewable energy sources decreases average daily household energy consumption by 6 percent;
- Due to continued growth and development in corridor greenfields, total corridor sequestration of carbon emissions decreases 20 percent from 2006 to 2035; and
- Total corridor multi-sector GHG emissions increase 15 percent from 2006 to 2035.

Scenario 2 – Comprehensive Transportation Investment with Supportive Land Use

Scenario 2 focuses on comprehensive long-range transportation strategy investment, policies, and programs consistent with the *Maryland Climate Action Plan* transportation policy options, the *Maryland Transportation Plan*[16] statewide transportation system goals, and corridor long-range needs. BRTB projected development trends are modified to support and maximize the return from multimodal transportation investment.

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[14] http://energy.maryland.gov/energyoutlookoverview.html

[15] This includes the combined effect of the 2011-2016 National Fuel Economy Standard, proposed 2017 – 2025 light-duty vehicle standards, proposed 2014-2018 medium/heavy duty vehicle standards, U.S. EPAs Renewable Fuels Standard, and the proposed regional Low Carbon Fuel Standard.

[16] http://www.mdot.maryland.gov/Planning/Maryland_Transportation_Plan/Index.html

Based on the 2035 BRTB forecast, the study team assumed more rapid growth in the corridor. This translated into additional corridor growth (15 percent more population, 22 percent more households, and 18 percent more employment than the 2035 Baseline). To support the transit investment listed below, all growth in addition to the baseline forecast occurs within one mile of fixed guideway transit in the corridor.

The key elements of this scenario include:

- Implement recommendations of the *Baltimore Regional Rail Plan* (Red Line, Green Line) (http://www.baltimorerailplan.com/);
- Accelerate strategic implementation of the *MARC Growth and Investment Plan* on the Penn Line (http://mta.maryland.gov/sites/default/files/marcplanfull.pdf);
- Complete *I-95 Section 200* and *Section 300* (http://www.mdta.maryland.gov/I95section200/home.html);
- *Statewide Trails Plan* – U.S. 40 cycletrack (on- or off-road bike path) from Aberdeen to Bayview MARC Station (http://www.mdot.maryland.gov/Planning/Trails/About.html);
- Comprehensive pedestrian improvements;
- Highway Needs Inventory roadway capacity and enhancement projects;
- *CHART (Coordinated Highway Action Response Team) Non-Constrained Deployment Plan* (http://www.chart.state.md.us/ReadingRoom/RR_StrategicPlanning.asp);
- *BRAC Public Transportation Plan* (Expand commuter bus on I-95, and local circulation) (http://www.mdot.maryland.gov/Planning/BRAC/Index.html);
- Consolidate planning/policy outcomes of *Maryland Electric Vehicle Infrastructure Council*, *Electric Vehicle Infrastructure Program* (EVIP), *Baltimore Electric Vehicle Initiative* (BEVI) http://www.mdot.maryland.gov/Planning/Electric_Vehicle/Index.html);
- Low-carbon/energy efficient capital investments – Signal synchronization, traveler information, truck stop electrification, traffic flow enhancements (CHART), bike/pedestrian infrastructure investment;
- Implement cordon charge/parking pricing in Baltimore CBD; and
- TOD at Green Line and MARC Penn Line Stations.

Summary Results

The results are based on a comparison to the 2035 Baseline assessment (unless otherwise noted). The BRTB travel model and modified socioeconomic data were used to produce the following set of key summary results for 2035.

- The change in population and employment added 267,000 daily person trips and 487,900 daily VMT in the corridor.
- The significant proposed transit investment and TOD style development increased the transit mode share from 1.1 percent to 2.3 percent.

- Average daily VMT per corridor household decreases from 51.6 to 45.8 miles.
- New transportation technologies reduced GHG per household by an additional 10 percent or 0.35 tons GHG annually in 2035 compared to 2006.

Scenario 3 – Smart Growth Development and Supportive Transportation Infrastructure

Scenario 3 is characterized by employing smart growth development and redevelopment concepts at Rosedale, Rossville, White Marsh/Middle River, Joppatowne, Edgewood, Riverside, Perryman, Aberdeen, and Havre de Grace. Transportation infrastructure investment is made to support the change in land use and development. Key elements of Scenario 3 include the following items:

- Distribution of corridor population and employment growth focused in activity centers and TOD. The scenario focuses on smart growth strategies and site design to encourage mixed income and multifamily housing, transit use, bike and pedestrian trips, resulting in minimizing VMT per household by reducing the need for motorized travel and reducing trip lengths, and by providing additional transportation options.
- To support the land use and development included in the scenario, rapid transit service along the length of the U.S. 40 corridor is included (bus rapid transit or light rail).
- As another transportation-supportive component, an interconnected local transit system connecting existing and new corridor residential developments to U.S. 40 BRT/LRT, employment along U.S. 40 in Baltimore County and surrounding the White Marsh area, and to new or expanding nodes in town centers and adjacent to APG.
- High-quality pedestrian and bicycle networks accessing transit facilities, and public and private services (libraries, schools, hospitals, government facilities, and civic buildings) are included to complement and reinforce town center land use and development components while also providing essential transportation connections by modes other than the auto for daily non-work travel needs.
- Consistent and linked travel demand management (TDM) and transportation marketing/ education programs implemented in the corridor are included as a programmatic element to support increased nodal population and employment density.
- Implement a statewide $0.02 per mile VMT fee in addition to existing motor vehicle fuel taxes to help stimulate alternative travel modes.

Summary Results

The results are based on a comparison to the 2035 Baseline assessment. The BRTB travel model and associated socioeconomic data were used to produce the following set of key summary results for 2035.

- Additional corridor growth compared to the 2035 Baseline (population 14 percent, households 21 percent, and employment 15 percent).
- All additional corridor growth occurs within one mile of U.S. 40 or adjacent to MARC Penn Line stations creating town centers.
- Population and employment adds 238,000 daily trips and 106,900 daily VMT in the corridor.
- Transit investment, redevelopment, and a $0.02 per mile VMT fee, decreases daily VMT per household from 51.6 miles to 43.2 miles.
- The type of housing development increases shares of single-family attached and multifamily households, decreasing average per household energy consumption.
- The overall GHG emissions per household decreases by 14 percent.

Scenario 4 – Energy Consumption and Supply, Conservation, and Sequestration

Scenario 4 was developed to address a multi-sector energy consumption and supply with strong land conservation and carbon sequestration strategy elements. The following elements were included in Scenario 4:

- A series of mandates, incentives, and challenges marketed and partially sponsored through *EmPOWER Maryland*[17], to spur the reduction of energy consumption in government, residential, commercial, and industrial sectors and to encourage development and use of low-carbon energy sources.
- Aggressive expansion of the scope of policies and programs consistent with the State Green Infrastructure Plan, local policies for agricultural land and natural resource preservation, more stringent policies and new best management practices for protecting areas with high sequestration potential, and continuation/expansion of programs that will also sequester carbon consistent with meeting targets of the Chesapeake Bay total maximum daily load (TMDL), *Watershed Implementation Plan*[18]. (See Appendix M)
- Transportation and land use elements were held constant with the 2035 Baseline (Scenario 1) socioeconomic forecast and planned infrastructure investment.

Summary Results

The results are based on a comparison to the 2035 Baseline assessment. All results were developed using non-transportation based assessment tools applied by Maryland Department of Environment (MDE) and Maryland Energy Administration (MEA). (See Appendix H)

[17] http://energy.maryland.gov/facts/empower.html

[18] http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/RestorationUnderway.html?tab2=2&tab1=2

- No change in corridor household totals, instead focus on increased mixed housing stock and affordability.
- Total residential sector energy consumption reduces 5 percent in 2035 as a result of changing housing types.
- The combination of renewable supply strategies and consumer-based efficiency strategies in 2035 decreases total GHG emissions from the residential sector by 50 percent.
- This is equivalent to a 30 percent reduction in average per household annual energy consumption.
- Reorientation of new development to maximize protection of lands with the highest opportunity to sequester carbon and protect natural resources, provides a 6 percent savings in total emissions.

Summary of GHG Emission Results for All Initial Scenarios

One of the central goals of the CNC project is to reduce GHG emissions well below 2006 levels. Scenario 2 and 3 test different population and employment growth forecasts (as compared to the 2035 Baseline), which added population and employment into the corridor. As a result, this report presents an assessment of GHG reductions based on a standardized household assessment. This approach allows a consistent and logical comparison across corridor scenarios. The associated results are included Tables 4.1 and 4.2.

Table 4.1 Percent and Absolute Change in GHG Emissions Compared to 2006

2035 Percent Reduction and Tons of GHG Reduced	Scenario 1 (2035 Baseline)	Scenario 2	Scenario 3	Scenario 4
Annual Transportation GHG Emissions per Household	-49% (7.7)	-71% (11.3)	-62% (9.8)	-49% (7.7)
Annual Non-transportation GHG Emissions per Household	-6% (0.6)	-6% (0.6)	-9% (1.0)	-58% (6.0)
Total Annual GHG Emissions per Household	**-31% (8.3)**	**-45% (11.9)**	**-41% (10.8)**	**-52% (13.7)**

Table 4.2 Contribution by Component to Overall Scenario GHG Reduction

2035 Percent Reduction	Scenario 1 (2035 Baseline)	Scenario 2	Scenario 3	Scenario 4
Transportation Sector (Contribution to the Total Transportation Sector Reduction)				
Transportation Investments and Development with Existing Vehicle Standards	19%	35%	37%	19%
Proposed Technology and Fuel Standards	30%	25%	25%	30%
Future Technology and Fuels (post-2025)		11%		
TOTAL Sector Reductions	***49%***	***71%***	***62%***	***49%***
Residential Sector (Contribution to the Total Residential Sector Reduction)				
Existing Maryland Programs (*EmPOWER Maryland*, Renewable Portfolio Standard)	6%	6%	6%	6%
New Energy Consumption Strategies	-	-	-	35%
New Energy Supply Strategies	-	-	-	13%
Multifamily Housing Strategies	-	-	3%	4%
TOTAL Sector Reductions	***6%***	***6%***	***9%***	***58%***

Scenario 1 – 2035 Baseline

Reflects a 49 percent reduction in transportation GHG emissions per household in 2035 compared to 2006 as a result of planned investment in MDOTs CTP and the BRTB long-range transportation plan, and new vehicle fuel efficiency standards through 2016 recently signed into law. Annual per household GHG emissions are reduced 6 percent by 2035 compared to 2006 as a result of *EmPOWER Maryland* and *Renewable Portfolio Standard* (RPS) programs. This reduction represents a low-end estimate, as the longer-term benefit and implementation of *EmPOWER Maryland* and the RPS is not well-defined beyond 2022 at this time.

Scenario 2 – Comprehensive Transportation Investment with Supportive Land Use

Reflects the largest reduction (71 percent) in annual transportation GHG emissions per household. The scenario includes a combination of expansive growth in corridor transit and transit-oriented development including extension of MTA light rail, bus rapid transit, and extensive upgrades to MARC service, optimized vehicle technology improvements well beyond current standards, and transportation pricing including congestion pricing on I-95. Proposed and future vehicle and fuel technologies contribute more than half of the GHG reductions.

Scenario 3 – Smart Growth Development and Supportive Transportation Infrastructure

Takes a more balanced land use and transportation approach with a focus on redistribution of forecasted growth into town centers and adjacent to transit. Combined with transit improvements focusing on existing infrastructure and extensive bike, pedestrian, and travel demand management program investment, the scenario reduces annual transportation GHG

emissions per household by 62 percent. The reorientation of household growth in the corridor to town centers, and the greater share of single-family attached and multifamily households do result in additional reduction in annual household GHG emissions. In Scenario 3, the combined transportation and land use strategies contribute more than 60 percent of the total transportation sector reductions.

Scenario 4 – Energy Consumption and Supply, Conservation, and Sequestration

Focuses exclusively on residential and commercial strategies to reduce energy consumption, deploy less carbon intensive energy supply options, and maximize the ability of natural lands in the corridor to sequester carbon. As a result annual GHG emissions per corridor household decrease 58 percent in 2035 compared to 2006. In Scenario 4, new energy consumption and supply strategies contribute to over 80 percent of the total household GHG emission reductions.

4.3 COMPREHENSIVE SCENARIO CONSIDERATIONS (SCENARIO 5)

Based on the findings of initial scenarios, the ISC developed a comprehensive corridor scenario that organized a specific set of strategies based on the results of the initial scenario assessment.

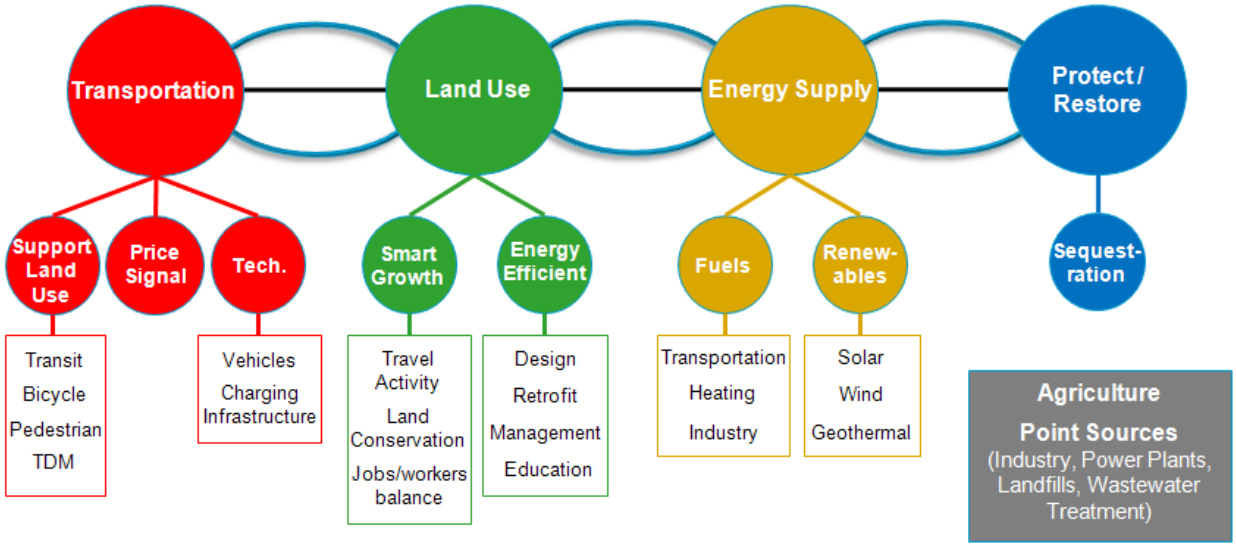
Key considerations used to define the key elements of Scenario 5 include:

- Land use (town centers) and pricing have a significant impact on transportation emissions;
- High-capacity transit investment reduces transportation emissions at a significant cost;
- Vehicle technology and fuels provides a significant impact with no change in mobility;
- Renewable energy supply and efficient consumption strategies decreases household and commercial emissions;
- Smart growth benefits conservation and sequestration potential; and
- Higher density housing increases energy efficiency and conserves green space.

After significant discussion with and input from the ISC, "Scenario 5" was organized around a strong "town center" concept within the U.S. 40 corridor and includes aggressive energy consumption, energy supply, and land conservation strategies along with supportive transportation infrastructure and program investment. The ultimate definition of Scenario 5 was constrained to include strategies that were considered by ISC members to be overall consistent with State and local transportation, economic, and environmental objectives. Scenario 5 focuses on a comprehensive approach combining the most efficient land use, transportation, conservation, energy consumption and supply strategies from Scenarios 2, 3, and 4 to maximize the reduction in household GHG emissions.

This systems approach takes into account the important interactions and linkages between the different major elements (transportation, land use, energy supply, and protection/restoration). Figure 4.2 presents the conceptual framework for developing Scenario 5 with the specific focus on maximizing benefits across all major elements.

Figure 4.2 Carbon Neutral Corridor Systems Approach



Based on the results of the initial scenarios, interactions between major components provided significant opportunities to increase GHG emission reductions. For example, within Scenario 3 (Smart Growth Development and Supportive Transportation Infrastructure) matching Smart Growth concepts with energy efficient housing provide significant benefits that would not be typically captured by simply assessing land use changes and associated benefits. Minimizing the consumption of undeveloped land also provides additional GHG benefits – through carbon sequestration – that would not be typically accounted for in a traditional land use study. In the development of Scenario 5, the study team and ISC made a conscious effort to identify and leverage the benefits where these interconnections best fit in the corridor.

4.4 Initial CNC Scenario Review with Corridor Stakeholders

The project was designed to engage local stakeholders in reviewing ideas, testing concepts, and acquiring feedback on potential strategies and scenarios that reduce carbon emissions. To inform the development of Scenario 5, the stakeholder process included interviews with representatives who have a strong local presence and knowledge of the project corridor.

The stakeholders selected for interviews represent a wide range of interests and are leaders in ongoing corridor activities that will help shape the future of a low-carbon future for U.S. 40 (the full stakeholder list is documented in Appendix I). This wide range of interests includes local chambers of commerce, business associations, community councils, major employers (including Franklin Square Hospital, the General Motors White Marsh Plant, Constellation Energy, and CSX Transportation) and other corridor leadership including representation from Aberdeen Proving Ground and the Chesapeake Science and Security Corridor.

The input collected from the interviews with these stakeholders was used to inform the development of Scenario 5 and identify additional key parties to meet with in the corridor. Key comments and outcomes included:

- Identified the potential for future partnerships between the public and private sectors, particularly from the perspective of General Motors and Constellation Energy;
- Provided insight into the local business community perspectives and priorities on the future of the corridor, particularly with regard to smart growth, public transportation, and transportation funding;
- Explained to the project team the diversity of socioeconomic backgrounds in the corridor and their divergent interests;
- Discussed the role of vehicle technology in reducing carbon emissions, particularly a goal for establishing the corridor as a premium market for electric vehicles;
- Noted ongoing successful and planned private sector green initiatives in the corridor, including renewable energy sources, employer-based commutes incentive programs, carbon offset programs, and community activities; and
- Identified other critical corridor stakeholders to interview including significant local business owners and advocacy groups.

All of the stakeholders have expressed interest in continuing their involvement in the process. Their continued feedback throughout the process was critical in helping the project team ensure that the plan is useful to State and local officials, local residents and organizations, and the business community.

5.0 U.S. 40 Carbon Neutral Corridor "Scenario 5" Multi-sector Approach and Results

The comprehensive U.S. 40 corridor scenario, "Scenario 5," focuses on an integrated approach of combining cost-effective and efficient land use, transportation, conservation, energy consumption and energy supply strategies for maximizing GHG emission reductions per corridor household and corridor job.

To develop a scenario that best represents the carbon neutral corridor (CNC) goals, the Interagency Steering Committee designed a corridor scenario that encompassed the best performing strategies included in Scenarios 2, 3, and 4, and considered where GHG reduction strategies would best work together to achieve more significant GHG reductions. Scenario 5 uses the corridor Baseline as its starting point and is characterized by a multi-sector approach represented through the five major elements below.

1. *Comprehensive Low-Carbon Land Use and Development*

- Through coordinating with existing State and local redevelopment and revitalization area designations and programs, focus all corridor development in town centers. Development occurs in a comprehensive context which includes supportive multimodal and energy efficient transportation modes, electric vehicle charging infrastructure, energy efficient and affordable housing types, and actions for aggressive conservation and protection of all corridor agriculture, forest, wetlands and watersheds, and pastures.
- Implement energy efficient new construction standards, energy use management technologies in government facilities, residential and commercial building retrofit and weatherization programs, business operations strategies, lighting and appliance replacement, and education programs on energy efficient practices.

2. *Multimodal and Energy Efficient Transportation*

- Support town center development through multimodal transit capacity expansion and enhancement, bicycle and pedestrian networks, and travel demand management programs.
- Improve system efficiency on I-95 and state highways through broad deployment of traffic signal coordination, active traffic management, traveler information and incident management, as well as congestion pricing on I-95 express toll lanes matched with corridor travel demand management programs.
- Expand the use of new vehicle technologies through agency purchasing programs supporting the use of low-carbon or electric vehicles, continue incentive programs and

public-private partnerships to expand the use of hybrid commercial vehicles, and create new incentive programs supporting private ownership of electric vehicles.

3. *Energy Supply*

- Extend the current *Renewable Portfolio Standard* with new and more aggressive goals for renewable energy use through 2035, and implement new incentives and programs for government, residential, and commercial installation of solar, wind, and geothermal energy units.
- Implement incentive programs or partner with private entities to deploy alternative fueling/electric vehicle charging infrastructure for use by the general public and commercial interests.

4. *Management and Restoration*

- Expand current programs that assist landowners in maximizing sequestration potential from forests, wetlands and agricultural lands, reduce nitrogen loads into the Chesapeake Bay, and protect environmentally sensitive areas. (See Appendix M)

5. *Other GHG Reduction Strategies*

- Create partnerships in the corridor that will help deploy pilot industrial sector energy consumption strategies including combined heat and power, and implement projects to generate usable energy from wastewater treatment and solid waste disposal processes.

5.1 SCENARIO DESCRIPTION

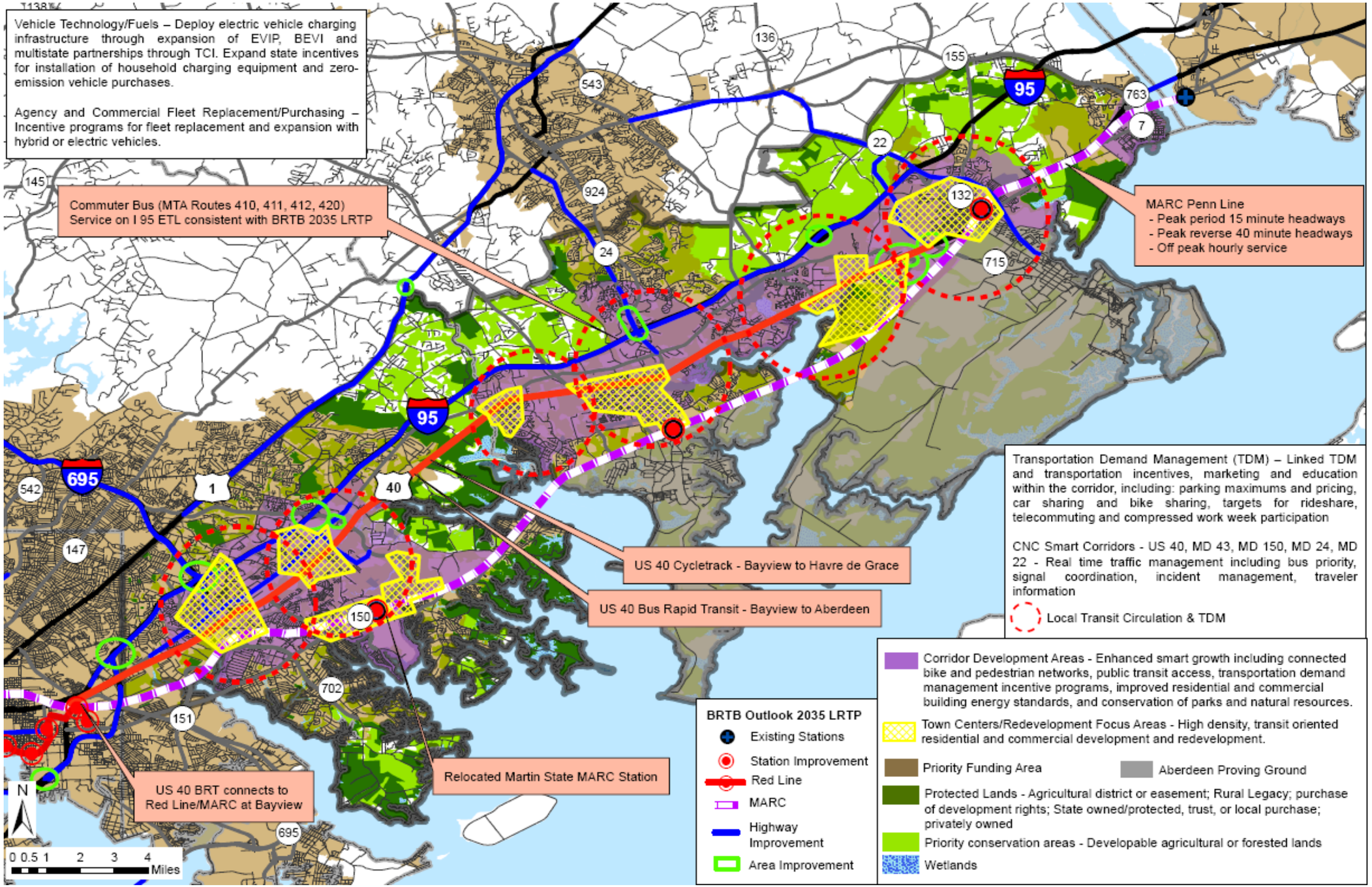
Table 5.1 presents the specific details of the components of Scenario 5, and Figure 5.1 presents a map of Scenario 5 strategy locations. Additional strategy details are provided in Appendix J.

Table 5.1 U.S. 40 Carbon Neutral Corridor
Scenario 5

Scenario Component	2035 Description
Low-Carbon Land Use and Development	
Corridor Town Centers – Attain the following development goals through revised zoning, development, and building codes: 75 to 90% of town center new households are multifamily or single-family attached, 75% of new town center households through 2035 are LEED rated/meet corridor goals to reduce energy consumption per household, and all multifamily/single-family attached developments include public electric vehicle charging accommodating 25% of residents. Development and revitalization of corridor town centers will include a sustained market for affordable housing through implementation of existing programs such as Community Development Block Grants, Community Investment Tax Credits, and Community Legacy.	
Town Center Conservation Strategies	Strategically expand urban parks along off-road trails (greenways), stream/river buffers, and current urban open space. Implement pilot programs/incentive programs for green roofs and urban tree planting.
Corridor Conservation and Protection Strategies	To support reorientation of corridor growth to town centers, to the maximum extent possible, deploy publically sponsored conservation and protection programs and partnerships aimed at maximizing protection of agricultural lands and natural areas.
Town Center Energy Consumption – New Construction	Make building code changes to include energy efficient design standards into all new building construction after 2020. All new buildings constructed after 2030 will produce the energy necessary to meet their consumption needs. Reduce per-unit-floor-area consumption of carbon-based electricity by 50% by 2020 and become 100% carbon neutral by 2030 within all government-owned and -leased buildings.
Corridor Energy Consumption – Retrofit/Weatherization	Basic energy retrofits and energy audits including replacing old technology and sealing leaks can reduce energy consumption by 30% to a maximum of 50%. Assume that 80% to 100% of all existing buildings perform basic retrofits given that they are very cost-effective. More extensive retrofits and HVAC system replacements are higher cost strategies with lower cost-effectiveness.
Corridor Energy Consumption – Energy Use Management	20% of all homes and businesses in the corridor are equipped with computer-based energy management systems for peak-load recognition, task management and allocation to off-peak hours of electricity demand etc.
Corridor Energy Consumption – Appliances/Lighting	50% of all households and commercial facilities replace their existing appliances and lighting systems with *EnergyStar* rated technologies.
Multimodal and Energy Efficient Transportation	
MARC Penn Line – MARC Growth and Investment Plan	Improve peak and off-peak headways (both directions).
	Hourly service in off-peak (both directions) and weekend service.
U.S. 40 Bus Rapid Transit (BRT) Corridor	BRT on U.S. 40 from MARC/MTA Red Line Bayview Station to Aberdeen MARC Station operating in exclusive lanes or on shoulders.
	5-minute headway in peak period (both directions), 20-minute headway in off-peak period (both directions). All BRT vehicles to be electric or hybrid.
Local Bus/Circulator Systems	Operating on 10-minute headways circulating both directions in the following town centers: Havre de Grace/Aberdeen, Edgewood/Joppatowne, White Marsh/Middle River, Rossville/Rosedale.
MTA Commuter Bus	MTA 120, 410, 411, 412, and 420 operating on I-95 express toll lanes.

Scenario Component	2035 Description
I-95 Section 200 (MD 43 to MD 22)	2 express toll lanes and 4 general purpose lanes from MD 43 to north of MD 543, 4 general purpose lanes from MD 543 to north of MD 22. Evaluate new options for peak-period pricing consistent with I-95 Corridor Coalition goals.
CNC – Smart Corridors	Implement consolidated real-time traffic management on state highways including: bus signal priority, adaptive traffic management and signal coordination, traveler information, incident management.
Bicycle Network	U.S. 40 cycletrack from Bayview to Havre de Grace.
	Corridor signed bike route system, and bike lanes and shared lane markings on collectors and minor arterials with direct access to all MARC stations.
Pedestrian Network	Buffered sidewalks on U.S. 40 in all town centers with street crossing amenities.
	Sidewalks on all streets crossing U.S. 40, parallel local streets developed as part of a new street grid within town centers, and access to MARC stations.
Transportation Demand Management (TDM)	Implement comprehensive and consistent TDM programs (ridesharing, guaranteed ride home, vanpool incentives) at emerging business/technology/warehousing parks in Aberdeen, Perryman, Edgewood, for existing and new major employers in the White Marsh/Middle River/Rossville areas.
Heavy-Duty Truck Auxiliary Power Units	Implement requirements and incentive programs for heavy duty truck APUs.
Commercial Vehicle Fleet Renewal	Incentives supporting purchasing programs for light/medium duty commercial vehicles (delivery trucks, service vehicles).
	Implement incentive-based program and private partnerships supporting deployment of charging infrastructure for commercial fleet electric vehicles.
Agency Vehicle Fleet Renewal	New purchasing programs for all agency fleet vehicles including buses (transit and school). Broad deployment of low-carbon refueling/charging infrastructure.
Private Vehicle Charging Infrastructure	Public deployment at travel plazas, park-and-ride lots, government facilities, schools, and incentives for household purchase and installation.
Energy Supply	
Renewable Portfolio Standard (RPS)	New RPS goal of 35% of electricity generated by renewable sources in 2035.
Distributed Generation (Solar, Geothermal)	To offset the up-front costs of installing residential solar and geothermal systems, increase existing grant percentages and provide tax benefits.
Transportation Fuels	Implement a regional low-carbon fuel standard that meets a target of a 10 percent reduction in mobile GHG emissions from low-carbon fuels in 2035.
Restoration and Sequestration	
Management/Restoration Strategies	Expand and implement new forest, wetland, riparian buffer, and agricultural management and restoration programs to mitigate degradation of land and maximize carbon sequestration potential.
Other	
Industrial/Manufacturing	Work with partners to implement pilot projects that reduce industrial energy consumption through combined heat and power and energy efficiency audits.
Wastewater/Solid Waste	Implement projects to harvest and generate usable energy from 25% of wastewater and landfill gas emissions.

Figure 5.1 U.S. 40 Carbon Neutral Corridor Scenario 5 Map



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5.2 SCENARIO 5 PERFORMANCE

The results of Scenario 5 show significant GHG emission reductions and multiple co-benefits based on an integrated assessment approach that accounts for how land use strategies, conservation and restoration, energy consumption and supply, and transportation can work together to reduce GHG emissions and overall energy consumption. Compared to 2006 the total corridor GHG emissions in Scenario 5 are reduced by **43 percent** in 2035 (**63 percent** per household). The full scope of Scenario 5 performance and emission results are presented in Appendix K.

Land Use and Development

The reallocation of population and employment growth in Scenario 5 represents an overall 54 percent increase in household growth in town centers and a **10 percent** increase in employment growth in town centers. The total population and employment growth in the corridor does not change compared to the 2035 Baseline (corridor population still grows **29 percent** and corridor employment **61 percent** from 2006 to 2035), only the distribution of growth changes.

Table 5.2 presents key associated transportation, conservation, and energy benefits of the reallocation and expansion of growth in Scenario 5. These include:

- The increased balance of workers and jobs within the corridor results in a higher share of person trips staying inside the corridor.
- The reallocation of growth in Scenario 5 results in an increase in acres of agricultural and natural land from **37 percent** in Scenario 1 (2035 Baseline) to **49 percent** in Scenario 5. New growth in the corridor maximizes the protection of agricultural and natural lands.
- The increased share of single-family attached and multifamily households results in a **4 percent** decrease in average energy consumption per corridor household.

Table 5.2 Scenario 5 - Associated Transportation, Conservation, and Energy Benefits from Land Use and Development Strategies

2035 Performance Measure	Scenario 1 (2035 Baseline)	Scenario 5
Person Trip Share Inside Corridor	67.1%	69.2%
Corridor Share of Agricultural/Forested Lands	36.7%	49.0%
Annual GHG Emission (tons) per Household[a]	9.89	4.33
Annual GHG Emission (tons) per Commercial Job[a]	6.93	2.23

[a] These results reflect the full benefits of changes in household type, energy consumption strategies, and energy supply strategies (does not include transportation benefits). The percentages as presented in the results summary reflect the change as a result only of the household type and energy consumption strategies (approximately 65 to 70 percent of the total reductions). The remaining 30 to 35 percent reduction comes from corridor energy supply strategies (see Page 5-19).

Aggressive energy efficient building standards for all household and commercial growth in the corridor, incentives for energy retrofits, weatherization, appliance replacement, and energy

management programs for existing households and businesses, reduces annual per household energy consumption by **55 percent** and reduces annual per commercial job energy consumption by **68 percent** compared to Scenario 1 (the 2035 Baseline).

Transportation

Increased population and employment densities in corridor town centers and adjacent to MARC Penn Line stations, a greater mix of housing types and income levels, and increased balance between workers located in the corridor and corridor jobs, emphasizes the importance of an integrated, multimodal transportation system in Scenario 5.

The first component of Scenario 5 transportation strategies supports corridor town center development by providing convenient options for town center residents to carpool, ride transit, walk, and bike. Compared to the Baseline, corridor commute to work transit mode share increases from **4.7 to 6.0 percent** in Scenario 5. In addition to transit, enhancements to corridor bicycle and pedestrian networks, and deployment of comprehensive employer-based travel demand management (TDM) programs, result in an additional VMT reduction of 5 percent in Scenario 5.

The second component of corridor transportation strategies increases operating efficiency of the transportation system. The combination of decreased corridor VMT (resulting from land use and transit strategies) matched with pricing on I-95 and other traffic management strategies on state highways decreases corridor p.m. peak-period VMT operating in severe congestion from **56 percent** in the 2035 Baseline to **52 percent** in Scenario 5. Extensive deployment of SHAs CHART program and corridor traffic management is estimated to reduce over **20,000 daily hours of vehicle delay** in the corridor.

The third component of corridor transportation strategies improves vehicle technology. Combination of existing and proposed Federal, regional, and State programs, along with new concepts reduces average grams of CO_2 emissions per mile for passenger cars and trucks from the 2006 fleet average of **433 grams per mile** to:

- The 2035 LDV fleet average with existing and proposed Federal standards is **223 grams per mile** (included in 2035 Baseline);
- The 2035 LDV fleet average with continued technology expansion beyond 2025 is **160 grams per mile**; and
- The 2035 LDV fleet average, assuming the share of VMT by electric vehicles increases from a forecast of **6 percent** to approximately **20 percent** by 2035, is **150 grams** per mile

This change equates to average light-duty vehicle fuel economy increasing from **20 to 21 miles per gallon** today to over **40 miles per gallon** by 2035. Table 5.3 presents the key performance measures for the Scenario 5 transportation components.

Table 5.3 Scenario 5 - Associated Transportation Benefits from Comprehensive Transportation Strategies

2035 Performance Measure	Scenario 1 (2035 Baseline)	Scenario 5
Corridor Daily Light-Duty VMT (1,000s)*	6,958.2	6,877.3
Daily VMT per Corridor Household	51.6	51.0
Corridor Home-Based Work Transit Mode Share	4.7%	6.0%
Total VMT Reduction from Bike, Pedestrian, and TDM Strategies (1,000s)**	–	(367.1)
Corridor Share of VMT by LOS E and F (p.m. peak period)	55.8%	51.9%
Total Reduction from Proposed or New Vehicle Technology Programs (mmt GHG)	(0.68)	(0.99)

Note*: The reduction in VMT in Scenario 5 compared to Scenario 1 (2035 Baseline) reflects the impact of multiple factors modeled through BRTBs regional travel demand model, including: relocation of forecasted population and employment growth to town centers and increased transit accessibility and level of service.

Note**: The reduction in VMT from bike, pedestrian and TDM strategies were estimated off-model and thus are reported separately from the other VMT performance measures.

Energy Supply

Alternative energy supply strategies are layered on residential, commercial, and industrial energy consumption strategies to result in a combination of lower rates of energy consumption and corridor energy sources that are on average less carbon intensive. The combination of both energy consumption and supply strategies reduce annual GHG emissions per corridor household by **56 percent** compared to the Scenario 1 (2035 Baseline), and annual GHG emission per corridor non-industrial jobs by **68 percent**. Energy supply strategies that include continued expansion of Maryland's renewable portfolio standard, and incentives for residential and business geothermal and solar installations contribute to **30 to 35 percent** of the total residential, commercial, and industrial sector GHG emission reductions. Transportation fuels strategies include ongoing implementation of EPAs Renewable Fuel Standard as well as implementation of a new Low-Carbon Fuel Standard as recommended by the Transportation and Climate Initiative (TCI)[19] that is estimated to reduce total on-road mobile source GHG emissions by **10 percent** in 2035.

Protect and Restore

As highlighted in Table 5.4, the reallocation of growth in the corridor results in preservation of developable agricultural and natural land uses. This change improves the potential to sequester GHG emissions by **0.05 mmt GHG** annually within corridor forests, wetlands, and soils. Strategies to restore and manage these land uses as well as enhance the urban tree canopy in the corridor result in an additional **0.20 mmt GHG** reduction as presented in Table 5.4.

[19]http://www.georgetownclimate.org/state-action/transportation-and-climate-initiative.

Table 5.4 Scenario 5 – Associated Sequestration Benefits from Protect and Restore Strategies

2035 Performance Measure	Scenario 1 (2035 Baseline)	Scenario 5
Total Forest Carbon Sequestration (annual million metric tons GHG)	(0.24)	(0.29)
Total Conservation and Restoration Strategies (annual million metric tons GHG)	0.00	(0.21)

Summary of Scenario 5

Scenario 5 reduces total corridor GHG emissions **43 percent** below 2006 levels (Table 5.5). On a annual per household basis in 2035, total annual GHG emissions decrease to **18.0 tons per household** in Scenario 1 (2035 Baseline), to **9.8 tons per household** in Scenario 5.

Table 5.5 Baseline and Scenario 5 Summary Results

GHG Emissions	2006	Scenario 1 (2035 Baseline)	Scenario 5 (2035)
Total Net Annual Corridor Emissions (mmt GHG)			
Total Net Corridor Emissions	4.24	4.86 15%	2.41 -43%
Total Net Annual Corridor Emissions per Household (Tons CO_2e)			
Annual GHG Emissions per Household (On-Road Transportation)	15.80	8.11 -49%	5.44 -66%
Annual GHG Emissions per Household (Residential Sector)	10.46	9.89 -6%	4.33 -59%
Annual GHG Emissions per Household (Total)	26.26	18.00 -31%	9.77 -63%
Percent Change From 2006 Total Corridor GHG Emissions			
Total Corridor Transportation Sector GHG Emissions		-20%	-39%
Total Corridor Other Sector GHG Emissions		36%	-34%
Total Corridor Multi-sector GHG Emissions		12%	-36%
Total Corridor Net Multi-sector GHG Emissions		**15%**	**-43%**

Table 5.6 includes a summary of the corridor GHG emission reduction results in tons of GHG per day in 2035 compared to the 2035 Baseline. In the table, the benefit of the U.S. 40 town centers in 2035 is combined with the benefit of all transportation system projects, programs, and technologies.

Table 5.6 Scenario 5 Summary Daily Results Compared to 2035 Baseline

Scenario 5 Component	Reduction from 2035 Baseline (Tons GHG per Day)
U.S. 40 Corridor Town Centers and Supportive Transportation Strategies	1,050
Corridor Energy Consumption	3,247
Industrial, Wastewater, and Landfill Strategies	789
Corridor Energy Supply	1,563
Corridor Conservation, Restoration, and Carbon Sequestration	702
Total	**7,351**

An alternative view of the benefits of the integrated corridor approach is to focus on the change in GHG emissions per corridor household resulting from the land use, transportation, energy consumption and supply strategies.

- **63 pounds** GHG per day reduction per household in 2035 compared to 2006 from U.S. 40 town centers and supportive transportation strategies (this equals up to a 4 gallon daily savings in gasoline consumption per household).
- **37 pounds** GHG per day reduction per household in 2035 compared to 2006 from residential energy consumption and supply strategies.

5.3 SCENARIO 5 COST-EFFECTIVENESS

There is a diversity of cost elements associated with U.S. 40 CNC strategies including:

- Planning, engineering, ROW acquisition or land purchase, and construction costs;
- Annual operating and maintenance costs; and
- Administrative and program management costs.

Components of U.S. 40 corridor Scenario 5 strategies include tax incentives, subsidies, and other fees to support implementation and adoption of low-carbon activities and programs. These approaches do not change the total societal cost of a GHG reduction strategy, but rather affect (sometimes significantly) the costs to individuals, businesses, or government agencies. They effectively represent transfers from one entity to another entity. These costs are not considered in the evaluation of cost-effectiveness but are emphasized in the discussion of the economic and equity implications of implementing the strategies.

The study limited its consideration of costs to only a qualitative view of implementation requirements and cost-effectiveness. This approach was chosen because the overall level of detail in developing Scenario 5 strategies has remained at the conceptual level. While some strategies have more explicit details identified, presenting a consistent cost approach across all strategies was considered beyond the scope of this pilot study.

Cost-Effectiveness

In the context of greenhouse gas mitigation, cost-effectiveness is typically measured in terms of dollars per metric ton of greenhouse gases reduced, providing a consistent and comparable metric for GHG reductions anticipated across strategies and deployed at varying intensities and at different geographic scopes.

Figure 5.2 presents the results of this analysis from 2010 through 2035. Strategies are arrayed on a continuum representing multiple effectiveness elements.

- **Payback Period –** The number of years it takes a strategy or program to "break even" on its up-front capital investment and annual operations costs compared against energy savings.
- **Variability of Benefits –** Strategies to reduce GHG emissions are often impacted by other conditions including external economic factors or land use decisions.
- **Ease of Implementation –** Presents a perspective on the relative requirements, barriers, and technology required to implement a strategy.
- **Level of Annual Maintenance and Operations Costs –** Strategies with ongoing high maintenance and operations cost, such as investment in transit, maintain a high cost per GHG reduction over time.

Figure 5.2 portrays the full range of strategies – strategies with quick payback periods (5 years or less), well understood/expected benefits, low implementation barriers, and low annual costs – and strategies with long payback periods or continuous net costs, variable benefits, and potentially significant implementation barriers. The overall scope of the continuum ranges from a net savings per ton of carbon to costs greater than $1,000 per ton of carbon. The midpoint of the continuum is in the range of $20 to $70 per ton. This range is based on the findings of a U.S. Government led interagency working group in 2010 looking at average costs through 2050.[20]

A critical consideration related to the cost-effectiveness assessment is the types of costs included. The results presented are based on an approach that considers public-sector implementation costs and direct monetary benefits to travelers, homeowners or business owners in terms of reduced energy consumption. Transportation efficiency and travel activity strategies reduce annual household energy consumption for transportation in Scenario 5 by 32 percent. Energy efficient building standards for all household and commercial growth in the corridor, incentives for energy retrofits, weatherization, appliance replacement, and energy management programs for existing households and businesses, reduces annual per household and per commercial job energy consumption by 55 to 68 percent.

Household Energy Cost Savings

Savings from household based energy consumption strategies result in significant improvements in residential energy efficiency (estimated at a 59 percent reduction per household compared to 2006), leading to reduced electricity demand and household energy cost

[20] http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf.

savings on the order of $800 annually per household compared to 2006 (based on current Maryland electricity rates per kwh).[21]

Household Transportation Cost Savings

Strategies that act to reduce daily household vehicle travel or act to reduce the amount of fuel consumed per mile of travel result in savings for household travel costs. Based on American Automobile Association (AAA) 2011 average driving costs[22] (including operating and ownership costs), total cost savings in 2035 compared to 2006 total $400 per household. This estimate assumes no change in the average cost of auto insurance, maintenance, depreciation, or fuel costs, excludes the cost of tolls, parking, or transit fares, and does not take into account savings or added costs from increased operation of electric vehicles or alternative fuel vehicles.

Cost Effectiveness Resources

The position of strategies on the cost-effectiveness continuum is based on a number of resources including:

- U.S. EPA Clean Energy Programs including information on benefits of building codes, combine heat and power, and *EnergyStar* appliances;[23]
- Maryland Energy Administration (MEA), *Maryland State Energy Investment Fund – Clean Energy Accomplishments (FY 2009-2010);*[24]
- MEA, *2010 Maryland Energy Outlook*;[25]
- Oak Ridge National Laboratory, *Weatherization Assistance Program Technical Memorandum, Background Data and Statistics*, 2010;[26]
- McKinsey and Company, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, 2007;[27] and
- U.S. DOT *Report to Congress: Transportation's Role in Reducing U.S. Greenhouse Gas Emissions*, 2009.[28]

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[21] Based on average electricity prices per kwh in the Baltimore-Washington area, October 2011 data from the US Department of Labor, Bureau of Labor Statistics. http://www.bls.gov/ro3/apwb.htm

[22] Based on AAA 2011 driving costs publication. http://www.aaaexchange.com/Assets/Files/201145734460.DrivingCosts2011.pdf

[23] http://www.epa.gov/cleanenergy/documents/suca/buildingcodesfactsheet.pdf.

[24] http://energy.maryland.gov/documents/fy09andfy10seifaccomplishmentsbook.pdf.

[25] http://www.energy.state.md.us/documents/MEOFINALREPORTJAN2010.pdf.

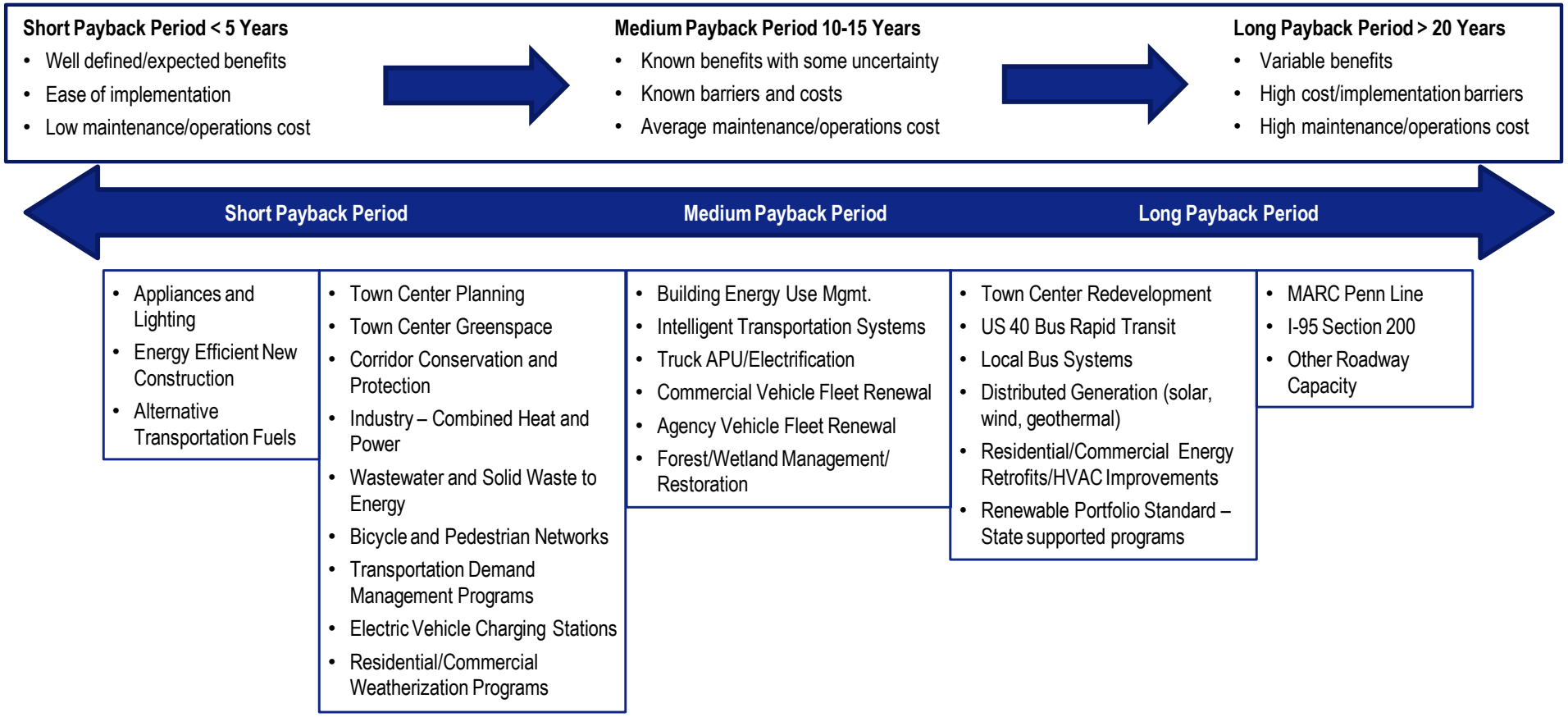
[26] http://weatherization.ornl.gov/pdfs/ORNL_TM-2010-66.pdf.

[27] http://www.mckinsey.com/en/Client_Service/Sustainability/Latest_thinking/Reducing_U.S._greenhouse_gas_emissions.aspx.

This research combined with transportation infrastructure cost information from MDOTs Consolidated Transportation Program and BRTBs *Outlook 2035* Long-Range Transportation Plan represent the full scope of information needed to interpret payback periods and other elements of cost-effectiveness presented in Figure 5.2.

[28] http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf.

Figure 5.2 Scenario 5 Component Comprehensive Cost-Effectiveness
2010-2035



5.4 INDIRECT COST BENEFITS

Indirect benefits and costs can be characterized as those costs to society that are not already paid by motor vehicle drivers and property/business owners, including the costs of air pollution and public health impacts.

Air pollution – Costs associated with air pollution from motor vehicles include public health, building and material damage, and environmental resource damage, including lost agricultural and forest productivity and ecosystem health. CNC strategies such as improved vehicle technologies, increased bicycling and pedestrian activity, and more energy efficient buildings act to reduce total emissions associated with the burning of fossil fuels. The U.S. 40 corridor is within the Baltimore region non-attainment area. Under the Clean Air Act, areas designated as non-attainment for a National Ambient Air Quality Standard are required to review their current transportation plans and programs to ensure conformity with the applicable State air quality implementation plan. The Baltimore region is designated nonattainment for eight-hour ozone and fine particulate matter ($PM_{2.5}$). The majority of strategies included in Scenario 5 act to support the region in attaining Clean Air Act standards.

Other environmental resources – Other environmental resource costs include water and soil pollution, and ecosystem/habitat loss and fragmentation. Water and soil pollution have elements that are directly related to vehicle/fuel use (leakage from vehicles, toxic metals in runoff, oil spills), as well as other elements that are not directly related (road salt, stormwater runoff). Water and soil pollution are also associated with site preparation activities and construction associated with new development, as well as runoff from parking lots and other impervious surfaces. Costs associated with ecosystem/habitat loss and fragmentation are primarily "fixed" costs, i.e., associated with the amount of roadway infrastructure built or the acres of parking lots, rather than the total distance driven. Scenario 5 identifies minimal roadway expansion beyond the long-range transportation plan, and with the focus on development in town centers as opposed to greenfields, preserves natural resources in the corridor.

5.5 CO-BENEFITS

Co-benefits refer to other outcomes of implementing CNC strategies that may lead to economic growth, improved transportation system safety and mobility, improved quality of life and public health, and reductions across all potential air and surface environmental impacts.

All of the U.S. 40 CNC strategies will result in lowered consumption of fossil fuels, and as such may have economic benefits to the extent that Maryland's dependence on importing energy is reduced. In addition improved transportation system operations, rail infrastructure, and more efficient land use will result in reduction in commercial vehicle delay and more efficient locations of distributors and receivers of goods leading towards reduced logistics costs.

Most transportation system efficiency strategies have significant mobility co-benefits, especially travel time savings and resulting economic benefits from reduced congestion (such as improved truck and rail freight movement and better access to employment). Land use and transit strategies also have mobility benefits for those who do not drive because of advanced age,

young age, disability, or income. Public health benefits can result from land use, bicycle and pedestrian, and transit strategies that encourage walking and biking. Land use, transit, and bicycle and pedestrian strategies also will reduce household expenditures on fuel and on vehicle operating and ownership costs by reducing demand for carbon-intensive travel. Vehicle efficiency and system efficiency strategies will reduce household expenditures on fuel through more efficient travel. Possible unintended consequences include mobility and equity impacts to lower-income populations from transportation pricing strategies that increase the cost of carbon-intensive travel beyond their willingness or ability to pay.

5.6 TIMEFRAME, IMPLEMENTATION BARRIERS, AND FUNDING

The eventual implementation of the strategies included in Scenario 5 will face a number of significant challenges or barriers, which must be addressed in order for the strategies to be successfully deployed. Several of those implementation barriers are outlined below and summarized in Table 5.7.

Financial (Costs) – A significant increase in current funding would be necessary to implement many of the strategies outlined in Scenario 5. This is particularly true for transportation infrastructure strategies that require both significant capital costs and annual operating and maintenance costs such as the MARC Growth and Investment Plan, I-95 Section 200, and U.S. 40 Bus Rapid Transit corridor. Other incentive or grant-based strategies for residential or commercial energy retrofits/enhancements or tax incentives for land conservation and sequestration require new budget set-asides or may impact local property tax receipts. Funding sources are variable, including for many strategies an expectation of Federal and private industry support.

Social – The social, environmental, and economic impacts of the Scenario 5 strategies will be distributed differently among the socioeconomic groups in the corridor. With careful implementation of the full Scenario 5 design, the corridor strategies together will enhance the corridor quality of life, mobility, and accessibility to employment and services for all income groups, grow economic activity, and protect the environment. Particular attention is also paid to balancing housing cost and housing location efficiency within the corridor. Some strategies will require careful assessment and mitigation of potential environmental impacts, particularly with regard to water quality effects on the Chesapeake Bay.

Programmatic – Some of the implementation strategies will face regulatory or legal challenges surrounding changes to current policy, legal precedents, and operations. In order for effective strategy implementation, some strategies will require the State and local governments to forge new and innovative working relationships. In addition, some of the strategies will require the development of new tracking or accounting mechanisms.

Political – While Scenario 5 could include modest increases in fees, any change could face challenging political barriers. New financial incentives are designed to provide benefits for implementing or participating in programs (particularly for protecting undeveloped land), but can affect overall public sector revenues. Overall, the strategies in Scenario 5 were mindfully developed with consideration of environmental justice and equity concerns. It is possible that

there may be some strategies that by their very nature could pose political challenges. This could include transportation fees, new development regulations or standards, or increased regulation on land uses.

Private Participation – Many of the strategies include an assumption that the private sector needs to be involved as both a planning and implementing partner. Depending on the existing strength of public-private relationships, developing these partnerships and bringing private funding to support implementation may be easy or very difficult.

The implementation barriers impact the interpretation of possible implementation timelines. In Table 5.7, implementation timelines are presented in terms of short, medium and long. Short refers to actions reasonably underway this decade, medium refers to activities underway in the 2020s, and long refers to activities after 2030.

Many of the strategies require upfront changes to regulatory or legal frameworks, planning and engineering, or development of new partnerships or programs. In these cases, many of these steps can occur before 2020 and create the structure for implementation activities from 2020 to 2030. Strategies with longer implementation timeframes beyond 2030 are similar in that they all have high initial capital costs, and likely require technological innovations to successfully deploy.

Table 5.7 Implementation Timeframe, Barriers, and Funding

Scenario Component	Implementation Timeframe	Implementation Barriers	Funding Sources
Low-Carbon Land Use and Development			
Corridor Town Centers Redevelopment	Develop supporting language/focus in Comprehensive Plan updates – **S**, Zoning code revision – **S**, Incentives-tax code changes, **S/M**, Redevelopment and new infrastructure – **M/L**	Legal (zoning, building codes, tax laws), developers/ private investors	State, Local, Private
Town Center Conservation Strategies	Develop supporting language/focus in Comprehensive Plan updates – **S**, Zoning, land use plan revisions – **S**, Program implementation – **M**	Legal (rewrite of zoning and building codes), private land-owners, developers	Local, Private
Corridor Conservation and Protection Strategies	Expanded conservation/protection programs – **S/M**, Land purchases/agreements – **S/M**	Costs, tax receipt impacts	State, Local, Private
Energy Efficient New Construction	Building code revision – **S**, Program tracking – **S/M**	Costs, developer willingness	Local, Private
Retrofit/Weatherization	Program development and implementation – **S**	Costs	State, Local, Private
Energy Use Management	Program development and implementation – **S**	Costs, technology limitations	State, Local, Private
Appliances/Lighting	Program development and implementation – **S**	Costs	State, Local, Private

Scenario Component	Implementation Timeframe	Implementation Barriers	Funding Sources
Multimodal and Energy Efficient Transportation			
MARC Penn Line – MARC Growth and Investment Plan	Improved operations/station upgrades – **S** New maintenance/storage facility – **M**, Upgrade bridges, new tracks, new stations – **L**	High capital and O&M costs, operations and capacity constraints, ROW needs, environmental impacts	Federal, State, Private
U.S. 40 Bus Rapid Transit (BRT) Corridor	New bus routes, improved stops – **S**, Dedicated ROW, transit signal priority, enhanced stops and level of service – **M**	Capital and annual O&M costs, maintenance of vehicle traffic operations	Federal, State, Local
Local Bus/Circulator Systems	New routes and stops – **S**	Capital and annual O&M costs, Service load factors	State, Local
MTA Commuter Bus	Revised route schedules/alignments – **S**	None	State
I-95 Section 200 (MD 43 to MD 22)	Planning/engineering/ROW/environmental analysis – **S/M**, Construction and opening – **L**	High capital cost, environ-mental constraints, political and regulatory barriers	Federal, State
CNC – Smart Corridors	Planning/engineering – S, Construction and operations – **M**	Cost, technology, enhanced communication networks	State, Local
Bicycle Network	Planning/engineering/ROW – **S**, Construction – **S/M**	Possible ROW acquisition costs	State, Local
Pedestrian Network	Planning/engineering/ROW – **S**, Construction – **S/M**	Possible ROW acquisition costs	State, Local
Transportation Demand Management (TDM)	Program development – **S**, Program startup and operation – **M**	Annual operation costs, employer willingness to participate	State, Local
Heavy-Duty Truck Auxiliary Power Units	Incentives for installing APUs – **S**	Costs, technology limitations, willingness to participate	State, Private
Commercial Vehicle Fleet Renewal	Pilot program – **S**, Incentives for fleet upgrades – **M**	Costs, willingness to participate, political	State, Private
Agency Vehicle Fleet Renewal	Revised purchasing standard – **S**, Vehicle replacement – **S/M**	Costs, technology limitations	State, Local
Private Vehicle Charging Infrastructure	Develop public – private partnerships and incentives for residential installation – **S/M**	Costs, technology limitations, electricity network impacts	State, Local, Private
Energy Supply			
Renewable Portfolio Standard (RPS)	Develop programs, incentives, negotiate with utilities – **S/M/L**	Costs, regulatory and legal barriers, political	State, Private
Distributed Generation (Solar, Geothermal)	Pilot programs and incentives – **S/M**	Capital costs	State, Private
Transportation Fuels	Regional low-carbon fuel standard – **S/M**, Incentive programs for development/distribution of fuels – **M**, Incentive programs for fleet retrofits and fueling stations – **M**	Institutional relationships, costs	Federal, State, Private

Scenario Component	Implementation Timeframe	Implementation Barriers	Funding Sources
Restoration and Sequestration			
Management/ Restoration Strategies	Develop programs, incentives, educational materials – **S**	Landowner willingness to participate	Local, Private
Other			
Industrial/Manufacturing	Pilot programs for energy management and combined heat and power – **S/M**	Costs, Technology limitations	State, Private
Wastewater/Solid Waste	Implement support programs, construct waste to energy facilities – **S/M**	Costs, Technology limitations	State, Private

Key: **S** (Short) – before 2020; **M** (Medium) – 2020-2030; **L** (Long) – beyond 2030.

6.0 Carbon Neutral Corridor Partnerships

The presentation of implementation considerations in Section 5.0 noted that interagency and public-private partnerships would be critical to implementing the multi-sector systems approach developed in Scenario 5. The design of the ISC and the membership of the stakeholder group included all major State agency implementation partners and representatives of private industry, corridor business owners, and corridor community groups – anticipating that support and eventual funding for implementing strategies would be led by these public and private groups.

The U.S. 40 CNC pilot study developed the framework of a process for multiple agency and private interests to work together in a specific corridor to build support for greenhouse gas reduction strategies. There are three critical relationships required for real corridor partnerships leading towards eventual implementation:

1. A working relationship among all implementing Federal, State and local agencies;
2. A working relationship between corridor industry and commercial interests and corridor community organizations, and special interest organizations; and
3. A working relationship between governmental agencies and corridor industry, commercial and community interests.

Table 6.1 presents the public and private interests that likely will be involved in some level of planning, funding, implementation, or management of the U.S. 40 Scenario 5 strategies. It is anticipated that new public funding sources will also be required at the Federal, State and local levels to implement both the infrastructure and programmatic strategies included in Scenario 5.

Table 6.1 Scenario 5 Strategies and Potential Partnerships

Scenario Component	Partnerships
Low-Carbon Land Use and Development	
Corridor Town Centers Redevelopment	County/City Planning and Zoning, Developers, MDP, MDOT/County DOT
Town Center Conservation Strategies	DNR/MDE, County Planning and Zoning, Developers
Corridor Conservation and Protection Strategies	DNR/MDE, County Planning and Zoning, Landowners, Trusts, Department of Agriculture (Maryland Agricultural Land Preservation Foundation)
Energy Efficient New Construction	MEA, DHCD, DBED, County Economic Development/Environment, Permits, Developers
Retrofit/Weatherization	MEA, DHCD, DBED, County Economic Development/Environment, Business/Homeowners

Scenario Component	Partnerships
Energy Use Management	MEA, DHCD, DBED, County Economic Development/Environment, Business/Homeowners
Appliances/Lighting	MEA, DHCD, DBED, County Economic Development/Environment, Business/Homeowners
Multimodal and Energy Efficient Transportation	
MARC Penn Line – MARC Growth and Investment Plan	FTA/FRA, MDOT (MTA), Amtrak, CSX
U.S. 40 Bus Rapid Transit (BRT) Corridor	MTA, Harford County Transit
Local Bus/Circulator Systems	MTA, Harford County Transit
MTA Commuter Bus	MTA
I-95 Section 200 (MD 43 to MD 22)	SHA/MDTA, FHWA
CNC – Smart Corridors	SHA, County DOTs/Public Works
Bicycle Network	SHA, County DOTs/Public Works, Developers
Pedestrian Network	SHA, County DOTs/Public Works, Developers
Transportation Demand Management (TDM)	MDOT/MTA, Developers, Business Parks, Major Employers, Harford County Transit/Harford County Commuter Assistance, County Economic Development
Heavy-Duty Truck Auxiliary Power Units	MDOT/MEA/MDE, Truck APU Manufacturers, Trucking Companies
Commercial Vehicle Fleet Renewal	MDOT/MEA/MDE, Trucking Companies
Agency Vehicle Fleet Renewal	MDOT, County Agencies, MEA
Private Vehicle Charging Infrastructure	MEA/MDOT, Charging Station Manufacturers
Energy Supply	
Renewable Portfolio Standard (RPS)	MEA, Constellation Energy and Other Power Companies
Distributed Generation (Solar, Geothermal)	MEA, Businesses and Homeowners, Manufacturers
Transportation Fuels	MEA/MDOT
Restoration and Sequestration	
Management/Restoration Strategies	DNR, MDE, Farms, Landowners
Other	
Industrial/Manufacturing	MEA, MDE, Manufacturers
Wastewater/Solid Waste	MEA, MDE, County Public Works/Water and Sewer/Solid Waste

7.0 Carbon Neutral Corridor Key Summary Findings

This CNC pilot study represented the first pilot project in Maryland where multidisciplinary stakeholders worked together to develop and test a variety of strategies with the goal of achieving significant and sustainable GHG emission reductions. The ISC played a significant role in partnering with MDOT in developing, testing, debating, and ultimately refining the U.S. 40 CNC scenarios. During the process several key findings were identified and are summarized below.

1. Significant carbon emission reductions can be achieved by taking a full multi-sector approach to implementing programs, while ensuring that energy efficiency and consumption remain primary programmatic objectives.
2. Addressing and accounting for the "cross-sector" benefits will achieve more significant emission benefits than simply planning and accounting for the singular benefits by sector or strategy focus (land use, transportation, conservation, energy supply and consumption).
3. Long-term sustainable benefits require a mix of short- and long-term strategies. All strategies can provide benefits – some more quickly and more cost-efficient than others.
4. The nexus between transportation, land use and development, and housing provides significant potential GHG benefits at the corridor scale and tangible benefits to corridor businesses and households. This is magnified when matching higher density and mixed-use development with low-carbon transportation and multiple/variety of housing choices.
5. Collaboration among State and local partners through existing Maryland designations and programs to support infill development, community redevelopment and revitalization, and mixed-income housing opportunities is important to help maintain growth in corridor town centers.
6. Smart Growth concepts can benefit land conservation and sequestration opportunities, particularly when they are implemented to minimize green field development and protect agricultural lands.
7. When Smart Growth design concepts account for urban land conservation through maintaining parklands and options for sequestering carbon (such as tree planting and green roofs), additional benefits are recognized.
8. GHG reduction strategies also have positive indirect benefits that extend into environmental programs and quality of life measures.
9. Vehicle technology and fuel advancements have a major positive impact on GHG reductions from the transportation sector.
10. Renewable energy sources can have a significant impact on carbon emissions based on cost, availability, distribution systems, and technology advances.

11. Green building standards along with building retrofit programs will have a significant positive impact on energy consumption.

It is important to recognize that the majority of the strategies included in the comprehensive U.S. 40 CNC scenario will require new working relationships between and among State and local agencies. Many of these are documented in Section 6.0 of this report. Linking transportation infrastructure investment with land development and various housing types provides an excellent example of this issue and required partnerships. Various State and local agencies set priorities and execute annual and long-term programs based on agency charters and individual agency priorities. While Maryland is one of the few states that provide linkages between transportation, land use and the environment, key agency priorities – both at the state and local level – will vary over time. While energy efficiency and conservation are important considerations that can have wide-ranging benefits, other competing priorities may dilute the importance of the GHG-related benefits and linkages that could be derived. The CNC study highlights the energy benefits that can realized when these functional areas and agency priorities are aligned around a topic like energy conservation and climate change.