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Agriculture, Forestry, and Waste Management Technical Work Group

Introduction

Forests and trees. Their benefits are extensive, complex, and beyond measure. Trees remove carbon dioxide from the air and store carbon in their trunks and branches; trees absorb and filter nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter less than 10 microns in size; trees release oxygen and intercept rainwater and dust. The process of evapotranspiration and shade from trees lowers summertime air and surface temperatures.

Shade and lower surface temperatures reduce the need for air conditioning in buildings thereby reducing the need for the production and transmission of electricity. Reduced energy production reduces emissions of greenhouse gases and carbon from power plants. Shade and lower surface temperatures reduce maintenance needs of infrastructure which, in turn, reduces the conversion of raw materials to asphalt and concrete which reduces the production of greenhouse gases from manufacturing plants, transportation and heavy equipment. Shade and lower surface temperatures reduce the evaporation of chemicals from car engines and reduces the need for air conditioning in cars. This reduces the amount of fuel burned and reduces the emissions from cars. And these are but a few examples.

Sustainable forest and urban forest management is essential to healthy, productive forests and trees that maximize mitigation for greenhouse gases and carbon sequestration. Additionally, these forests serve as the preferred land use for avoiding emissions. In the face of climate change, it is critical that we do everything within our power to increase the amount and enhance the condition of forests and trees everywhere. Their benefits span arenas making them our single most cost-effective tool for mitigating for climate change.

Summary List of Draft Priorities for Analysis – 2012 and 2020

Option No.	Policy Option		GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2008 2020	Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
AFW-1	Forest Management for Enhanced Carbon Sequestration (With Mitigation of Forest Loss Due to Insects, Disease, Pests, and Invasive Species)		0.04	0.09	0.66	89.1	135	Pending
AFW-2	Managing Urban Trees and Forests for Greenhouse Gas Benefits (With Mitigation of Forest Loss Due to Insects, Disease, Pests, and Invasive Species)		0.73	1.90	13.3	–2,017	-152	Pending
AFW-3	Afforestation, Reforestation, and Restoration of Forests and Wetlands a. Afforestation b. Riparian areas		a. 0.21 b. 0.02	a. 0.6 b. 0.1	a. 3.9 b. 0.6	a. 112.7 b. 27.6	a. 29 b. 46	Pending
AFW-4	Protection and Conservation of Agricultural Land, Coastal Wetlands, and Forested Land a. Agricultural land b. Forested land c. Coastal Wetlands		a. 0.11 b. 2.2 c. NQ	a. 0.28 b. 2.7 c. NQ	a. 1.93 b. 30.5 c. NQ	a. 168.6 b. 1,128.7 c. NQ	a. 87 b. 37 c. NQ	Pending
AFW-5	"Buy Local" Programs for Sustainable Agriculture, Wood, and Wood Products	a. Farmer's Market	0.010	0.032	0.198	–33.1	–167	Pending
		b. Local Produce	NQ	NQ	NQ	NQ	NQ	
		c. Locally Grown and Processed Lumber	NQ	NQ	NQ	NQ	NQ	
AFW-6	Expanded Use of Forest and Farm Feedstocks and By-Products for Energy Production	Biomass (Inc. Ag. Residue, Forest Feedstocks, and Energy Crops)	0.116	0.50	2.83	34.1	12	Pending
		Methane Utilization From Livestock Manure and Poultry Litter	0.014	0.04	0.25	0.06	0.2	
AFW-7	In-State Liquid Biofuels Production	Ethanol	0.36	0.91	2.73	219	80	Pending
		Biodiesel	0.10	0.17	1.41	10.5	7	
AFW-8	Nutrient Trading With Carbon Benefits		0.054	0.14	0.99	–29.7	–30	Pending
AFW-9	Waste Management Through Source Reduction and Advanced Recycling		9.34	29.2	184	–1,118	–6	Pending
	Sector Total After Adjusting for Overlaps[a]							
	Reductions From Recent Actions							
	Sector Total Plus Recent Actions							

NQ = not quantified; TBD = to be determined; MMt = million metric tons; CO_2e = carbon dioxide equivalent.

Note that negative costs represent a monetary savings.

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Summary List of Draft Priorities for Analysis: 2015 and 2020

Option No.	Policy Option		GHG Reductions ($MMtCO_2e$) 2015	2020	Total 2008 2020	Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
AFW-1	Forest Management for Enhanced Carbon Sequestration (With Mitigation of Forest Loss Due to Insects, Disease, Pests, and Invasive Species)		0.06	0.09	0.66	89.1	135	Pending
AFW-2	Managing Urban Trees and Forests for Greenhouse Gas Benefits (With Mitigation of Forest Loss Due to Insects, Disease, Pests, and Invasive Species)		1.17	1.90	13.3	–2,017	–152	Pending
AFW-3	Afforestation, Reforestation, and Restoration of Forests and Wetlands a. Afforestation b. Riparian areas		a. 0.4 b. 0.05	a. 0.6 b. 0.1	a. 3.9 b. 0.6	a. 112.7 b. 27.6	a. 29 b. 44	Pending
AFW-4	Protection and Conservation of Agricultural Land, Coastal Wetlands, and Forested Land d. Agricultural land e. Forested land f. Coastal Wetlands		a. 0.170 b. 2.4 c. NQ	a. 0.28 b. 2.7 c. NQ	a. 1.93 b. 30.5 c. NQ	a. 168.6 b. 1,128.7 c. NQ	a. 87 b. 37 c. NQ	Pending
AFW-5	"Buy Local" Programs for Sustainable Agriculture, Wood, and Wood Products	a. Farmer's Market	0.016	0.032	0.198	–33.1	–167	Pending
		b. Local Produce	NQ	NQ	NQ	NQ	NQ	
		c. Locally Grown and Processed Lumber	NQ	NQ	NQ	NQ	NQ	
AFW-6	Expanded Use of Forest and Farm Feedstocks and By-Products for Energy Production	Biomass (Inc. Ag. Residue, Forest Feedstocks, and Energy Crops)	0.22	0.50	2.83	34.1	12	Pending
		Methane Utilization From Livestock Manure and Poultry Litter	0.02	0.04	0.25	0.06	0.2	
AFW-7	In-State Liquid Biofuels Production	Ethanol	0.85	0.91	2.73	219	80	Pending
		Biodiesel	0.14	0.17	1.41	10.5	7	
AFW-8	Nutrient Trading With Carbon Benefits		0.09	0.14	0.9	–29.7	–30	Pending
AFW-9	Waste Management Through Source Reduction and Advanced Recycling		17.0	29.2	187	–1,118	–6	Pending
	Sector Total After Adjusting for Overlaps[a]							
	Reductions From Recent Actions							
	Sector Total Plus Recent Actions							

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NQ = not quantified; TBD = to be determined; MMt = million metric tons; CO_2e = carbon dioxide equivalent.

Note that negative costs represent a monetary savings.

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AFW-1. Forest Management for Enhanced Carbon Sequestration

Policy Description

Healthy, sustainable and productive forests provide a vast array of benefits. Sustainable forest management enhances environmental benefits and increases social and economical benefits, as well. This policy enhances productivity of healthy sustainable forests. Benefits from this option include: increased rates of carbon dioxide (CO_2) sequestration in forest biomass through healthier forests, increased amounts of carbon stored in harvested, durable wood products, and the availability of renewable biomass for energy production.

Healthy and vigorous forests provide direct benefits to greenhouse gas (GHG) reductions as noted above but also serve as the preferred land-use for avoiding emissions and capturing airborne GHGs. Yet, upon protecting forest for reducing GHGs, it is incumbent upon the owner of those forests to attend to the necessary stewardship activities needed to keep these forests healthy and vigorous such that they most able to meet the desired GHG objectives.

Practices may include: supplemental planting on poorly stocked lands, age extension of managed stands, thinning and density management, fertilization and wood waste recycling, expanded use of short-rotation woody crops (for fiber and energy), expanded use of genetically preferred species, modified biomass removal practices, and/or fire management and risk reduction.

Programs that reduce populations of invasive and damaging insects, diseases, plants and other pests enhance forest health and long-term sustainability. Reducing pressure from invasive species increases benefits from forests, helps mitigate GHG emissions and sequester more carbon. Threats from invasive species are increasing in number and severity, especially since forestlands are more vulnerable due cumulative effects of other stressors. Some native species populations exceed the carrying capacity of the habitat, undermining regeneration efforts, and therefore sustainability. For example, the over-abundance of white-tailed deer places excessive browse pressure on regeneration and understory plants in all forests. It is difficult to quantify the effects of invasive species growth on emissions as the costs of implementation and the efficacy of management strategies can vary widely.

Policy Design

Education and outreach especially for citizens and land managers will be an important part of this goal both to underscore importance of forests and to teach best management practices for forests.

Goals Related to Forest Management:

- Improve sustainable forest management on 25,000 acres of private land by 2020.
- Improve sustainable forest management on 100% of state-owned resource lands by 2020.

Goals Related to Forest Pests and Invasive Species (not quantified):

- Develop prioritization process of invasive species, identifying species of high priority for targeted action.
- Shift decision-making efforts to plan ahead for invasive species problems—move towards prevention or proactive management rather than control and reactive treatments.

Parties Involved: Maryland Department of Natural Resources (DNR), Maryland Department of the Environment (MDE), Maryland Department of Agriculture, Maryland State Highway Administration (SHA), counties, Chesapeake Bay Program, Natural Resource Conservation Service (NRCS), United States Forest Service – State and Private Forestry (USFS-SPF), private land owners, public land owners, private sawmills, landscaping industry, nursery industry, Maryland Cooperative Extension and Master Gardeners, and artisan community.

Implementation Mechanisms

- Outreach and education on best forest management practices
- Outreach and education about invasive species and control methods.
- Revise the Forest Conservation Act.
- Use a bona fide certification system with the aim to certify all state-owned forest lands as sustainably managed.
- Support a Sustainable Forestry Act that encourages enhanced carbon storage in forests, use of durable wood products, and use of wood biomass for energy while maintaining healthy forest ecosystems.
- Use offset funds to enhance forest management on private lands and reduce conversion to other land uses (see existing programs below).
- Include sustainable forest management in the Regional Greenhouse Gas Initiative (RGGI) Model Rule.
- Develop mechanism to aggregate products from smaller land holdings to compete in meaningful markets.
- Investigate the feasibility of legislation restricting sale of priority non-native invasive species.

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Related Policies/Programs in Place

Forest Conservation Act.

Incentive programs for private forestland owners (e.g. Woodland Incentive Program, Forest Conservation and Management Agreements, Wooldland Assessment Program, Tax Modivication for Forest Management program, etc.) which either provide cost-share funds or tax breaks for appropriate management of their forests.

Types(s) of GHG Reductions

CO_2 (quantified): Enhancement of annual carbon sequestration from forest growth and reforestation through forestry management programs.

CO_2 (not quantified): Remove fuels that contribute to wildfire emissions. Maintain carbon sequestration through the production of durable wood products. Reduce emissions by reducing use of fossil fuels replaced by energy from woody biomass. Reduce emissions by preventing the release of carbon from dead and dying trees. Reduce wildfire emissions by maintaining healthy forests.

Estimated GHG Reductions and Net Costs or Cost Savings

- **Data Sources:**

Forest type distribution in Maryland and land ownership statistics are from USDA Forest Inventory and Analysis (FIA), http://fia.fs.fed.us.

USDA Forest Service (USFS) Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the U.S. Department of Energy (DOE) Voluntary GHG Reporting Program).

- **Quantification Methods:**

While experts largely agree that sustainably managed forests can probably store substantially more carbon on an annual basis than forests that are not managed sustainably, few data are currently available to quantify exactly what kinds of sites can store exactly how much additional carbon, and under what silvicultural regimes. Furthermore, some existing forests are undoubtedly already being managed sustainably, such that determining the amount of acreage available for improved forest management can be difficult.

To calculate the effect of improved forest management on carbon sequestration in Maryland, the additional carbon stored as a result of improved forest management was indexed using data on rates of carbon storage in average loblolly-shortleaf pine stands compared with carbon storage rates in high-productivity intensively managed loblolly-shortleaf pine stands in the Southeast (NE-GTR-343, Tables A39 and A40). The index of incremental carbon storage was calculated over a 90-year time period to capture the slowdown in forest carbon sequestration that typically occurs in maturing forest stands. Soil carbon was assumed to remain constant with time because there is no change in estimates of soil carbon pools over time in the 1605(b) guidelines. The incremental rate of carbon (C) storage due to intensive management in loblolly-shortleaf pine stands, relative to average loblolly-shortleaf pine stands in the Southeast is roughly 5% (Table 1-1).

Table 1-1. Carbon sequestration rates under average and intensive management scenarios for loblolly-shortleaf pine forests in the Southeast U.S. following clear-cut harvest

Forest Type	MtC/ac (0 yr)	MtC/ac (90 yr)	MtC/ac/yr	Increment in MtC/ac/ yr Due to Management
Loblolly-shortleaf pine stands (NE-GTR-343 Table A39)	10.7	60.5	0.553	
Loblolly-shortleaf pine on high productivity sites under intensive management (NE-GTR-343 Table A40)	14.9	67.0	0.579	5%

Forests in Maryland are 63% oak-hickory, with 10% oak-pine and 11% loblolly-shortleaf pine.[1] A mixture of forest types comprises the remaining 16% of forest land area. Co-efficients for improved productivity in oak-hickory and oak-pine stands were not available. The rate of carbon sequestration due to improved forest management in these forest types was thus calculated as a proportion of average carbon sequestration in forests under typical management, using the 5% value calculated for incremental carbon storage in loblolly-shortleaf pine stands (Table 1-2).

Table 1-2. Estimated carbon sequestration rates on forestland under intensive management

Forest Type	MtC/ac (0 yr)	MtC/ac (65 yr)	MtC/ac/yr	MtC/ac/yr Under Intensive Management
Oak-Hickory (GTR NE 343 Table A3)	23.0	72.7	0.765	0.800
Oak-Pine (GTR NE 343 Table A4)	25.9	63.4	0.577	0.604
Loblolly-shortleaf pine (GTR NE343 Table A39)	10.7	51.8	0.632	0.662

Forest carbon sequestration rates under baseline conditions (no improved forest management) were based on published carbon stocks (tons carbon per acre in forest biomass) for oak-hickory and oak-pine in the Northeast and for loblolly-shortleaf pine stands in U.S. Southeast (USFS GTR-343). Annual rates of carbon sequestration (tons carbon sequestered per acre per year) were calculated by subtracting total carbon stocks in forest biomass of 65-year-old stands from total carbon stocks in forest biomass of new stands and dividing by 65. An average for 65-year-old stands was used to reflect the typical stand age of forests in the Northeast region.

Quantification for this option was based on a combined goal of achieving enhanced forest management on 25,000 acres of private land and 100% of state-owned forestland by 2020. Based on 2004 Forest Inventory and Analysis (FIA) data, state-owned forests total 749,975 acres[2] in Maryland, roughly 31.2% of the 2.4 million forested acres statewide. Other forest land ownership entities in the State include the US Fish and Wildlife Service (42,561 acres), county and municipal government (41,148 acres) and privately-owned forests (1,567,846 acres). This acreage includes all land that is both classified as forest by FIA and owned by the State of Maryland, regardless of which branch of State government is currently responsible for managing that forest.

A linear ramp-up in implementation is assumed. Thus, each year from 2008 to 2020, the analysis assumes that 1,923 acres of private land and 57,690 acres of public land are added to the land base practicing sustainable forest management. The effect of policy implementation is thus the incremental carbon stored on these lands, over and above that which would be expected if enhanced forest management were not implemented. Both baseline and policy implementation scenarios assume that the distribution of forests affected by the program will reflect the distribution of forests statewide: 70% oak-hickory, 15% oak-pine and 15% loblolly-shortleaf pine. Acreage enrolled in the program in one year is assumed to continue sequestering additional

[1] USDA Forest Service Northern Global Change Program, http://www.fs.fed.us/ne/global/pubs/books/epa/states/MD.htm
[2] FIA EVALIDator version 1.0, http://fiatools.fs.fed.us/

carbon in subsequent years. Table 1-3 summarizes the total carbon storage resulting from enhanced forest management.

Table 1-3. Additional acreage and carbon sequestration resulting from expanded land base participating in sustainable forest management

Year	Private Land Added to Sustainable Forest Management This Year	Added in Prior Years	Public Land Added This Year	Public Land Added in Prior Years	Additional Carbon Storage ($MMtCO_2e/yr$)
2008	1923	0	57,690	0	0.007
2009	1923	1,923	57,690	57,690	0.014
2010	1923	3,846	57,690	115,381	0.022
2011	1923	5,769	57,690	173,071	0.029
2012	1923	7,692	57,690	230,762	0.036
2013	1923	9,615	57,690	288,452	0.043
2014	1923	11,538	57,690	346,142	0.051
2015	1923	13,462	5,7690	403,833	0.058
2016	1923	15,385	57,690	461,523	0.065
2017	1923	17,308	57,690	519,213	0.072
2018	1923	19,231	57,690	576,904	0.080
2019	1923	21,154	57,690	634,594	0.087
2020	1923	23,077	57,690	692,285	0.094
Total	**25,000**		**749,975**		**0.658**

The economic cost of implementing enhanced forest management on forest acreage is a one-time cost (over and above the cost to implement standard management techniques) of improved forest management practices, and is estimated to be $151.50/acre. This value is an average of values from other states where similar policy options have been quantified: Vermont, where a value of $3 per acre was used,[3] and Montana, where a value of $300 per acre was used.[4] Clearly, there is little consensus about what is required to implement an enhanced forest management program, and as a result the estimates of how much it will cost to implement these policies varies widely. State-specific data would substantially improve the validity of the estimate of economic costs for this option in Maryland. At $151.50/acre, and using a discount rate of 5%, the net present value (NPV) of this option is $89.1 million (Table 1-4), with an overall cost-effectiveness of $135.31 per tCO_2e stored.

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[3] http://www.vtclimatechange.us
[4] http://www.mtclimatechange.us

Table 1-4. Total economic costs for implementing improved forest management on combined private and public acreage in Maryland

Year	Carbon Sequestered ($MMtCO_2e$/ yr)	Total Cost	Discounted Cost
2008	0.007	$9,031,439	$9,031,439
2009	0.014	$9,031,439	$8,601,371
2010	0.022	$9,031,439	$8,191,782
2011	0.029	$9,031,439	$7,801,697
2012	0.036	$9,031,439	$7,430,188
2013	0.043	$9,031,439	$7,076,369
2014	0.051	$9,031,439	$6,739,399
2015	0.058	$9,031,439	$6,418,475
2016	0.065	$9,031,439	$6,112,834
2017	0.072	$9,031,439	$5,821,746
2018	0.080	$9,031,439	$5,544,520
2019	0.087	$9,031,439	$5,280,496
2020	0.094	$9,031,439	$5,029,043
Total	**0.658**	$117,408,713	**$89,079,360**

- **Key Assumptions:**
  - Carbon storage resulting from sustainable management of oak-hickory and oak-pine types is indexed to incremental carbon storage in loblolly-shortleaf-pine forests, as quantified using methods in NE-GTR-343.
  - One-time costs to implement enhanced forest management are $151.50/acre, and include costs over and above standard costs for forest management operations.
  - Forest types added to the pool of sustainably managed forests will reflect the distribution of forests statewide.

Key Uncertainties

GHG emissions from management activities such as harvest are not included in this analysis. To provide clarity about the effects of policy implementation, it would be important to quantify the changes in emissions resulting from changes in management practices due to policy implementation.

Additional Benefits and Costs

As markets are developed, additional biomass generated via enhanced forest management will be used first for long-term storage in durable wood products then for beneficial uses such as biofuels and energy. The biomass generated from improved management practices could be used for durable wood products and energy production. The quantification described above assumes that additional carbon is stored in the forest.

Forest certification will likely be necessary for participation in RGGI market, but effects of certification is not quantified here because its effects on carbon storage are uncertain and because the costs are difficult to quantify.

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MWG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MWG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MWG]

AFW-2. Managing Urban Trees and Forests for Greenhouse Gas Benefits

Policy Description

Healthy, sustainable urban forests are essential to our social, economic, and environmental welfare. This policy option maintains and improves the health and longevity of trees in urban and residential areas. Trees in urban areas help avoid emissions from power production and from the operation and maintenance of built structures and infrastructure. Further, urban trees contribute to lower summertime temperatures at street level. Reduced heat slows the formation of ground-level ozone as well as the evaporation and volatilization of organic compounds from vehicles. Trees also take in CO_2 for photosynthesis, storing carbon in their biomass through growth. Trees likewise reduce ambient concentrations of volatile organic compounds, nitrous oxide, fine particulate matter and other air and water pollutants.

Statewide, urban canopy cover in Maryland is 40.1% (Nowak, USFS). This option seeks to increase the canopy cover of urban trees throughout the state. Planting additional trees in-state may also: increase the utilization of wood recovered from urban trees for energy production or in value-added products for long-term carbon storage, encourage species diversity while extending survival and longevity rates through the creation of amenable microclimates, and address insects, invasive species and disease in urban forest settings, though these impacts are not quantified here.

Policy Design

Educate the public and legislators on the importance of urban forests for ozone and temperature regulation leading to reduced energy use.

Goals:

- Enhance green infrastructure planning including tying green areas together (not quantified).
- Develop incentives to better use urban wood recovery directed towards the highest order wood product (not quantified).with the remainder recovered for biomass to energy conversion (see AFW-6).
- Achieve urban tree canopy goal of 50% (averaged over all urban land use types) by 2020.

Goals Related to Forest Pests and Invasive Species (not quantified):

- Develop prioritization process of invasive species, identifying species of high priority for targeted action.
- Shift decision-making efforts to plan ahead for invasive species problems—move towards prevention or proactive management rather than control and reactive treatments.

Timing: See quantified goal above.

Parties Involved: Maryland Department of Natural Resources (DNR), Maryland Department of the Environment (MDE), Maryland Department of Agriculture, Maryland State Highway

Administration (SHA), counties, municipalities, Chesapeake Bay Program, Natural Resource Conservation Service (NRCS), United States Forest Service – Urban and Community Forestry (USFS), private land owners, public land owners, private sawmills, the artisan community, landscaping industry, nursery industry, arborist industry, Maryland Cooperative Extension and Master Gardeners.

Implementation Mechanisms

- Encourage planting programs in all communities, including a replacement program for dead trees where a tree with equal potential is planted in as good or better site to maximize longevity and efficacy
- Insert urban tree planting strategy and objectives in all comprehensive plans
- Encourage local counties to identify, maintain and augment street tree populations
- Outreach and education on the significance of trees and their role in our built environment.
- Monitor and report plantings at local level.
- Provide enhanced funding from conservation programs like Program Open Space to local jurisdictions to implement policies (like wood recovery and canopy goals) and/or to plant trees.
- Legislation restricting sale of priority non-native invasive species.
- Outreach and education about invasive species and control methods.
- To strengthen, fund, and support this act, add urban tree canopy (UTC) goals to the Urban Community Forest Act.

Related Policies/Programs in Place

Urban Community Forestry Act

Chesapeake Bay Commission 2020 goals for Maryland committed to by the Governor include by 2020, have urban canopy goals for 50% of the area developed primarily before stormwater management regulations (pre-1984).

(Local artisans building furniture from old growth urban trees?)

Types(s) of GHG Reductions

- **CO_2** (quantified): Avoidance of emission of carbon dioxide and associated GHGs through the reduction of heating and cooling needs in urban areas. Carbon sequestration due to tree growth.
- **CO_2** (not quantified): Reduction of surface temperatures reducing volatilization of gasses from vehicles. Maintaining carbon sequestration by creating durable wood products. Reduce use of fossil fuels by using wood waste for energy.

Estimated GHG Reductions and Net Costs or Cost Savings

- **Data Sources:**

- Data about existing and potential urban tree canopy cover for Maryland from: Galvin et al. 2006a: A Report on Baltimore City's present and potential Urban Tree Canopy. Galvin et al. 2006b: A Report on Annapolis' present and potential Urban Tree Canopy. Galvin et al. 2008: A Report on the City of Frederick's Existing and Possible Urban Tree Canopy. Maryland Department of Natural Resources – Forest Service.
- Information about current numbers of trees in urban forest and annual carbon storage in urban trees in Maryland from Nowak et al., USFS, Northern Research Station, Urban Forest Effects on Environmental Quality State Summary data for Maryland (http://www.fs.fed.us/ne/syracuse/Data/State/data_MD.htm).
- Fossil fuel reductions through reduced demand for cooling and protection from wind from: McPherson and Simpson (1999). Carbon Dioxide Reduction Through Urban Forestry, USFS PSW-GTR-171.
- Data on costs and benefits of tree planting from McPherson, E.G. et al. 2006. Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting. USDA Forest Service Pacific Southwest Research Station General Technical Report PSW-GTR-200.
- Additional data on benefits of tree canopy in Maryland are from Galvin, M. 2007. A Report on Hyattsville's Street Trees. Maryland Department of Natural Resources – Forest Service.

- **Quantification Methods:**

The following quantifies the cumulative impact on carbon sequestration and avoided fossil fuel emissions of incrementally increasing existing tree canopy cover in Maryland. Specifically, AFW-2 seeks to achieve a 50% urban canopy cover goal by 2020. Currently, Maryland's urban areas are 40.1% forested (Nowak, USFS), so this goal recommends a 25% increase over the existing canopy cover by 2020. The goal of 50% is based on recent assessments of existing and potential UTC in Maryland. For example, Baltimore currently has a canopy cover of 20% and a goal of 46.3% is recommended as feasible within the 2030-2036 time frame (Galvin et al. 2006a). Annapolis' urban areas are currently 41% forested, and a 50% goal is recommended within the same timeframe (Galvin et al. 2006b). Frederick is currently only 12% forested (Galvin et al. 2008), but there appear to be no obvious barriers to increasing its UTC. While the UTC analyses cited above recommend a longer timeframe to reach the UTC targets, this analysis seeks to quantify the effects of policy implementation within the 2008-2020 timeframe described by the Mitigation Working Group (MWG).

Currently Maryland contains 89.4 million urban trees; this option quantifies the effect of adding 22 million new trees total by 2020. The number of trees planted each year is constant at roughly 1.7 million per year, with the target number of trees planted by 2020.

GHG benefits are twofold: direct carbon sequestration by planted trees and avoided GHG emissions from strategic tree planting to reduce energy demand due to heating and cooling.

A. Direct Carbon Sequestration in Urban Trees

Annual carbon sequestration per urban tree is calculated as 0.006 tCO_2/tree/year, based on statewide average data reported by the USFS. This is the average annual per-tree carbon sequestration value when the total estimated urban forest carbon accumulation in Maryland (544,000 tCO_2/year) is divided by the total number of urban trees in Maryland (89.4 million).

Since trees planted in one year continue to accumulate carbon in subsequent years, annual carbon sequestration in any given year is calculated as the sum of carbon stored in trees planted in that year, plus the sequestration by trees that were planted in prior years. Because it simply takes the difference between total live C stocks at two points in time, this stock change approach accounts for normal tree mortality.

B. Avoided Fossil Fuel Emissions

Offsets from avoided fossil fuel use for heating and cooling are the sum of three different types of savings: avoided emissions from reduced cooling demand, avoided emissions from reduced demand for heating due to wind reduction (this benefit is only available for evergreen trees), and enhanced fossil fuel emissions needed for heat due to wintertime shading. Calculations for avoided fossil fuel offsets are based on calculations presented by McPherson et al. in GTR-PSW-171 (Table 2-1). For this analysis, it was assumed that half of the trees would be planted in residential settings, or close enough to buildings to result in avoided emissions. For the trees where this avoided emissions benefit is available, it was further assumed that the trees planted would be evenly split among residential settings with pre-1950, 1950–1980, and post-1980 homes, and that all planted are medium-sized evergreens. These avoided emission factors assume average tree distribution around buildings (i.e. these fossil fuel reduction factors are average for existing buildings, but do not necessarily assume that trees are optimally placed around buildings to maximize energy efficiency). These factors are also dependent on the fuel mix (coal, hydroelectric, nuclear, etc.) in the region, and are thus likely to change if the electricity mix changes from its 1999 distribution.

Table 2-1. Factors used to calculate CO_2e savings ($MMtCO_2$e/tree/year) from reduced need for fossil fuel for heating and cooling, and from windbreak effect of evergreen trees

Fossil Fuel Offsets: Evergreen Trees (Mid-Atlantic Climate Region)				
Housing Vintage	**Shade–Cooling**	**Shade–Heating**	**Wind–Heating**	**Net Effect**
Pre-1950	0.0168	–0.0315	0.1294	0.1147
1950–1980	0.0275	–0.0403	0.1555	0.1427
Post-1980	0.0232	–0.0324	0.133	0.1238
Average	**0.0225**	**–0.0347**	**0.1393**	**0.1271**
Average ($MMtCO_2$e)				**1.2707E-07**

Source: McPherson et al., 1999.

C. Overall GHG Benefit of Urban Tree Planting

Total GHG benefits are calculated as the sum of direct carbon sequestration plus fossil fuel offset from reduced cooling demand and wind reduction (Table 2-2).

Table 2-2. Overall GHG benefit ($MMtCO_2$e/year) of implementing AFW-2

Year	Trees Planted This Year	Trees Planted in Previous Years	GHG Sequestered ($MMtCO_2$e/yr)	GHG Avoided ($MMtCO_2$e/yr)	Overall GHG Savings ($MMtCO_2$e/yr)
2008	1,698,440	0	0.0379	0.1079	0.1458

2009	1,698,440	1,698,440	0.0758	0.2158	0.2916
2010	1,698,440	3,396,879	0.1136	0.3237	0.4374
2011	1,698,440	5,095,319	0.1515	0.4316	0.5832
2012	1,698,440	6,793,759	0.1894	0.5395	0.7289
2013	1,698,440	8,492,198	0.2273	0.6474	0.8747
2014	1,698,440	10,190,638	0.2652	0.7554	1.0205
2015	1,698,440	11,889,078	0.3030	0.8633	1.1663
2016	1,698,440	13,587,517	0.3409	0.9712	1.3121
2017	1,698,440	15,285,957	0.3788	1.0791	1.4579
2018	1,698,440	16,984,397	0.4167	1.1870	1.6037
2019	1,698,440	18,682,836	0.4546	1.2949	1.7495
2020	1,698,440	20,381,276	0.4924	1.4028	1.8952
Total		**22,079,716**	**3.4471**	**9.8196**	**13.2667**

D. Cost Analysis

Economic costs of tree planting are calculated as the sum of tree planting and annual maintenance, including the costs of program administration and waste disposal. Economic benefits of tree planting include the cost offset from reduced energy use, as well as the estimated economic benefits of services such as provision of clean air, hydrologic benefits such as storm water control, and aesthetic enhancement.

The cost of tree planting in Maryland was assumed to be $275/ tree.[5] This is a one-time cost incurred in the year of planting. Annual maintenance costs include pruning, pest management, administration, removal, and infrastructure repair due to damage from trees. Over a 40-year period, these costs were estimated at $22/tree/year, based on McPherson et al. (2006). This value assumes a medium-sized evergreen tree, and is an average of trees under public and private management. This value is consistent with per-tree annualized maintenance costs published for other states and regions. It was assumed that trees planted in the first year of policy implementation would still be living at the end of the policy implementation period; in other words, the effects of tree mortality are not explicitly accounted for in the analysis of the numbers of trees planted to achieve the canopy goals described above.

The economic benefit of planting urban trees includes the value of aesthetic improvement, air and water quality improvements, stormwater management, and energy savings. Annual economic benefit per tree was estimated at -$96.30/ tree/ year, using information from Galvin et

[5] Mike Galvin, Supervisor, Urban and Community Forestry, Maryland DNR. Personal communication with J. Jenkins, January 2008. Range of costs estimated at $250-300.

al. (2007) on the economic value of Hyattsville, Maryland's urban forest. Consistent with convention, the economic benefit per tree planted is a negative number since the economic benefit outweighs the cost of the option. When the economic benefit of an option outweighs its cost, then the resulting net economic cost is negative.

Net economic costs for this option are calculated as the difference between costs of planting + maintenance and economic benefit realized by urban trees. Negative costs therefore refer to net economic benefits, where estimated benefits exceed overall costs. For this analysis, net economic benefit per tree was estimated at –$74.30/tree/year. Discounted costs were calculated assuming a 5% discount rate (Table 2-3). AFW-2 has a net economic benefit of -$152.00/$tCO_2$e mitigated.

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Table 2-3. Economic benefits and costs of implementing AFW-2

Year	Trees Planted This Year	Trees Planted in Previous Years	Total Economic Benefit	Net Benefit (Costs Minus Benefits)	Discounted Net Benefits
2008	1,698,440	0	$0	$467,070,909	$467,070,909
2009	1,698,440	1,698,440	$163,559,740	$340,876,842	$324,644,611
2010	1,698,440	3,396,879	$327,119,480	$214,682,774	$194,723,605
2011	1,698,440	5,095,319	$490,679,221	$88,488,707	$76,439,872
2012	1,698,440	6,793,759	$654,238,961	–$37,705,361	–$31,020,294
2013	1,698,440	8,492,198	$817,798,701	–$163,899,428	–$128,419,491
2014	1,698,440	10,190,638	$981,358,441	–$290,093,496	–$216,472,233
2015	1,698,440	11,889,078	$1,144,918,182	–$416,287,563	–$295,847,799
2016	1,698,440	13,587,517	$1,308,477,922	–$542,481,631	–$367,172,921
2017	1,698,440	15,285,957	$1,472,037,662	–$668,675,698	–$431,034,317
2018	1,698,440	16,984,397	$1,635,597,402	–$794,869,766	–$487,981,084
2019	1,698,440	18,682,836	$1,799,157,142	–$921,063,833	–$538,526,947
2020	1,698,440	20,381,276	$1,962,716,883	–$1,047,257,901	–$583,152,386
Total		**22,079,716**	**$12,757,659,738**	**–$3,771,215,443**	**–$2,016,748,473**

- **Key Assumptions:** Economic costs and benefits of urban tree cover. Feasibility of accelerated implementation of UTC recommendations.

Key Uncertainties

TBD – [as needed and approved by the TWGs]

Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MWG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MWG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MWG]

AFW-3. Afforestation, Reforestation, and Restoration of Forests and Wetlands

Policy Description

Increasing forest and tree cover provides additional benefits for mitigation of GHGs in addition to sequestration. This policy option promotes forest cover and associated carbon stocks by regenerating or establishing healthy, functional forests through afforestation (on lands that have not, in recent history, been forested including agricultural lands) and reforestation (on lands with little or no present forest cover) where current beneficial practices are not displaced. Successful establishment requires commitment for as long as 20 years. Forest patches should be sufficient in size to function as a community of trees and related species.

In addition, this policy promotes the implementation of practices such as soil preparation, erosion control, and supplemental planting to ensure conditions that support forest growth. Identify areas, including all wetlands, in need of physical intervention to return forest habitats to full vigor. Additional areas of concern are linking islands of fragmented forests to restore function, recovering severely disturbed lands and reversing the effects of continued toxicity on those disturbed lands.

Policy Design

Carbon sequestration via afforestation is important, but other ancillary benefits provided by forests, in terms of green space, quality of life, and avoided emissions are also critical and add to the value of forestland for the community (see Introduction).

Maryland is a member of the Regional Greenhouse Gas Initiative (RGGI) (http://www.rggi.org), which mandates the existence of an inter-state CO_2 Budget Trading Program to reduce emissions from the power sector (RGGI applies to fossil fuel-burning plants larger than 25MW). Beginning with implementation of the CO_2 Budget Trading Program on January 1, 2009, emissions entities are permitted to use offset projects to meet up to 3.3% of their emissions limitations (this could increase to 5% and 10% in later years). Specific uses of revenues from the sale of carbon credits are at the discretion of states.

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To be eligible to participate in the Program, an offset project must submit to specific reporting requirements as documented in the RGGI Model Rule (http://www.rggi.org/docs/model_rule_corrected_1_5_07.pdf). In addition, to be eligible for RGGI as currently written a forest offset project must:

- Be an afforestation project (i.e. land must have been in a non-forested condition for at least 10 years prior to commencement of the offset project);
- Be protected in perpetuity via a conservation easement;
- Commit to management in accordance with widely accepted environmentally sustainable forestry practices, designed to promote the restoration of native forests by using mainly native species and avoiding the introduction of invasive nonnative species; and

- (If commercial timber harvest is planned) Enroll in a certification program such as those offered by the Forest Stewardship Council, Sustainable Forestry Institute, American Tree Farm System, or such other similar organizations.

Additional categories for offset projects may be added to the list of eligible projects, at the discretion of individual states. For example, reforestation projects or forest management projects may eligible to participate in the CO_2 Budget Trading Program at some future point.

While the above requirements are prerequisites for participation in the RGGI offset program, all categories of afforestation and reforestation projects will reduce the atmospheric GHG burden. In addition, all categories of easements (in perpetuity or long-term) will have GHG benefits. Thus AFW-3 is not limited to projects that are eligible for RGGI participation, and the associated costs of easement purchase and certification have been excluded from the quantification.

Wetlands and Marshes

Carbon storage and methane emissions from wetlands in Maryland (and North America more broadly) are highly uncertain in these complex ecosystems. In many cases, wetlands are a natural sink for carbon but can also be a source of methane when decomposition occurs after extended highly anaerobic conditions. Other wetlands, such as salt water marshes, are different as they support carbon sequestration but emit negligible amounts of methane because sulfate in saline water suppresses the development of methane-generating organisms.

The complexities of these ecosystems make the net carbon equivalent balance (i.e. sinks less GHG outputs) for fresh water wetlands inherently difficult to measure. Salt water marshes are more straight forward and *The First State of the Carbon Cycle Report*[6] identifies a mean carbon accumulation rate for conterminous United States tidal marshes as 2.2 million grams of carbon per hectare per year.

Research is necessary to reduce the uncertainties in carbon and methane fluxes in wetlands to provide better information on the appropriate management techniques and the potential for GHG emissions savings through effective management, restoration, and conservation of wetlands.

Regardless of the type of wetland or the net carbon balance, there are potential risks that significant amounts of carbon stored could be released into the atmosphere if these areas are not appropriately maintained. This highlights the need to preserve and restore these ecosystems, from both a greenhouse and local environmental perspective.

Goals:

- Establish sufficient acreage in forests to offset loss of 900 acres each month to development, beginning in June 2008 and continuing through December 2020.

[6] King, A.W., L. Dilling, G.P. Zimmerman, D.M. Fairman, R.A. Houghton, G. Marland, A.Z. Rose, and T.J. Wilbanks (eds.) *The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research*. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, USA, See http://www.climatescience.gov/Library/sap/sap2-2/final-report/default.htm

- Establish riparian buffers at a rate of 900 (is this a typo asks Dan Rider) miles/year (50-foot width either side of stream) to 2020, and continue until 70% of all stream miles in the state are buffered (Chesapeake Bay Forest Conservation Initiative, December 2007).

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Increase wetland area (non-quantified goal). **Timing:** See goals, above.

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Parties Involved: DN**R, SHA,** MDA, MDE, Chesape**a**ke Bay Program, NRCS, counties, private land owners

Implementation Mechanisms

- Outreach and education
- Green infrastructure plans
- Forest Conservation Act
- Forest Conservation Management Act (FCMA) – provides landowners a reduction in property taxes on lands actively managed for forest conservation including newly planted areas
- Also other property and inheritance tax incentives
- Economic incentive to private landowners including promotion of non-traditional products such as hunting leases and passive recreation
- Review fee-in-lieu dollars (amount and use) within the Forest Conservation Act. Fees should be available for easements and set at fair market values. Fee-in-lieu should be used as a last resort and in amounts that make it.
- Allowances from RGGI auctions should be available for reforestation and restoration.
- Recommend that the Commission for Climate Change and RGGI increase acknowledgment and importance of forests as significant in climate change mitigation

Related Policies/Programs in Place

Forest Conservation Act: See example from Washington County in implementation of the Forest Conservation Act (Forest Conservation Ordinance, adopted in 1993).[7]

Chesapeake Bay Commission 2020 goals for Maryland committed to by the Governor include restoring an additional 25,000 acres of forest buffers, or other areas of high value to water quality outside of prime agricultural land, by 2020.

Offset requirements that the Department of Transportation reforest an equal amount of acreage as is developed for major highways. Note: utilities are not currently required to offset fue to development. A bill is before the legislature to address this issue (SB 654).

Types(s) of GHG Reductions

CO_2: Increasing annual carbon sequestration from establishing forest and riparian cover.

[7] http://www.washco-md.net/washco_2/pdf_files/legal/forestcn.pdf

Estimated GHG Reductions and Net Costs or Cost Savings

- **Data Sources:**
  - USDA Forest Service (USFS) Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report GTR-NE-343 (also published as part of the DOE Voluntary GHG Reporting Program).
  - USFS Forest Inventory Analysis data, provided by the USFS for the Maryland Forestry Inventory and Forecast (Jim Smith, USFS).
  - Walker et al. 2007. Terrestrial carbon sequestration in the Northeast: Opportunities and Costs, Part 3A: Opportunities for Improving Carbon Storage through Afforestation of Agricultural Lands.
- **Quantification Methods:**

A. Afforestation

1. GHG benefit

Forests planted on land not currently in forest cover will likely accumulate carbon at a rate consistent with accumulation rates of average forest cover in the region. Therefore, carbon sequestered by afforestation activities was assumed to occur at the same rate as carbon sequestration in average Maryland forest. Average carbon storage was found based on USFS GTR-NE-343 assuming afforestation activity with a forest type distribution of 70% Oak-hickory, 15% Oak-Pine and 15% Loblolly-Shortleaf Pine. This distribution is reflective of the average forest composition in Maryland, and is based on USDA Forest Service Forest Inventory and Analysis statistics.[8] A 45-year project period was assumed, such that the rate of forest carbon sequestration under afforestation projects for an average acre in Maryland was estimated at 1.2 $tC/acre^{-1}/year^{-1}$ (Table 3-1). Forests planted in one year continue to sequester carbon in subsequent years. Thus, carbon storage in a given year is calculated as the sum of annual carbon sequestration on cumulative planted acreage.

Table 3-1. Forest carbon sequestration rates for afforestation activity

Forest Type	MtC/ac (0 yr)	MtC/ac (45 yr)	MtC/ac/yr
Oak-Hickory	0.8	56.2	1.2
Oak-Pine	1.7	48.5	1.0
Loblolly-Shortleaf Pine	1.7	41.9	0.9
Weighted Average			**1.2**

The rate of afforestation was estimated at 900 acres/month, for a total of 10,800 acres afforested annually. In 2008, it was assume that policy implementation would only occur over 7 months (beginning June 2008), so 6,300 acres would be afforested in that year. Between 2008 and 2020, a total of 135,900 acres would be afforested under AFW-3, for a total of 3.9 $MMtCO_2e$ stored (Table 3-2).

Table 3-2. Acreage planted each year under AFW-3, and total carbon sequestered

Year	Acres Planted This Year	Acres Planted in Prior Years	Carbon Sequestered (MtC/yr)	Carbon Sequestered

[8] http://www.fs.fed.us/ne/global/pubs/books/epa/states/MD.htm

				(MMt CO_2e/yr)
2008	6,300	0	7,256	0.027
2009	10,800	6,300	19,695	0.072
2010	10,800	17,100	32,135	0.118
2011	10,800	27,900	44,574	0.163
2012	10,800	38,700	57,013	0.209
2013	10,800	49,500	69,452	0.255
2014	10,800	60,300	81,891	0.300
2015	10,800	71,100	94,331	0.346
2016	10,800	81,900	106,770	0.391
2017	10,800	92,700	119,209	0.437
2018	10,800	103,500	131,648	0.483
2019	10,800	114,300	144,087	0.528
2020	10,800	125,100	156,527	0.574
Total		**135,900**		**3.903**

2. Economic Costs

Estimated per acre costs for afforestation in Maryland were obtained from Walker et al. (2007), who surveyed state foresters, regional foresters, or other foresters and related specialists in the US Forest Service, universities, and forest companies and reported results on a state-by-state basis. Costs include site preparation, labor, seedlings, and herbivore protection (Walker et al. 2007). Per-acre afforestation costs in Maryland were estimated to be $1,180 and $980 for hardwoods and softwoods, respectively. Following the distribution of forest types used to calculate the GHG benefit of forest planting (see above), it was assumed that 70% of the planted forests would be hardwoods with the remainder in softwoods. Thus, the weighted average cost to plant an acre of forest in Maryland was estimated at $1,105. This is a one-time cost incurred in the year of planting. Based on this information, the net present value (NPV) for this option is $112.7 million, with a levelized cost-effectiveness of $28.88/ ton CO2e (Table 3-3). This analysis ignores the likely economic benefits of afforestation, in terms of services such as clean air and clean water, reduced flooding, aesthetic effects, and other benefits. These benefits are typically more difficult to quantify than the tangible costs of tree planting, but they should be considered in the analysis of economic costs and benefits of afforestation activity.

Table 3-3. Economic costs of afforestation

Year	Acres Planted	Total Cost	Discounted Cost
2008	6,300	$6,961,500	$6,961,500
2009	10,800	$11,934,000	$11,365,714
2010	10,800	$11,934,000	$10,824,490
2011	10,800	$11,934,000	$10,309,038
2012	10,800	$11,934,000	$9,818,131
2013	10,800	$11,934,000	$9,350,601
2014	10,800	$11,934,000	$8,905,335
2015	10,800	$11,934,000	$8,481,271
2016	10,800	$11,934,000	$8,077,401
2017	10,800	$11,934,000	$7,692,763
2018	10,800	$11,934,000	$7,326,441

2019	10,800	$11,934,000	$6,977,563
2020	10,800	$11,934,000	$6,645,298
Total	**135,900**		**$112,735,545**

B. Riparian forest

1. GHG benefit

The annual rate of riparian forest establishment was calculated from the goals as established by the Chesapeake Bay Forest Conservation Initiative (2007),[9] which describe a goal of establishing 900 miles/ year of 50-foot-wide buffers by 2020, continuing until 70% of all stream miles are buffered. This goal corresponds to establishing 5455 acres/ year of riparian forest by 2020. A linear ramp-up toward the goal was assumed (Table 3-4).

The most common species in riparian buffers statewide are loblolly pine (21% of total stocking), green ash (10%) and sweet gum (8%). Other species in smaller proportions make up the remainder of the trees found in riparian buffers.[10] Thus statewide, it was assumed that riparian forests would be 50% elm-ash-cottonwood and 50% loblolly-pine forest types (Table 3-5). A 45-year project period was assumed, such that the rate of forest carbon sequestration in riparian projects for an average acre in Maryland was estimated at 0.9 $tC/acre^{-1}/year^{-1}$. Forests planted in one year continue to sequester carbon in subsequent years. Thus, carbon storage in a given year is calculated as the sum of annual carbon sequestration on cumulative planted acreage (Table 3-4).

Table 3-4. Acres planted and Carbon stored in riparian forests in Maryland.

	acres planted this year	acres planted in prior years	C sequestered (MMtCO2e/yr)
2008	420	0	0.001
2009	839	420	0.004
2010	1259	1259	0.008
2011	1678	2517	0.014
2012	2098	4196	0.021
2013	2517	6294	0.029
2014	2937	8811	0.038
2015	3357	11748	0.049
2016	3776	15105	0.062
2017	4196	18881	0.075
2018	4615	23077	0.091
2019	5035	27692	0.107
2020	5455	32727	0.125
cumulative totals	38182		0.625

[9] http://www.chesapeakebay.net/press_ec2007forests.aspx
[10] Riparian Forest Buffer Survival and Success in Maryland, April 2001. Maryland DNR Forest Service Research Report DNR/FS-01-01, http://dnrweb.dnr.state.md.us/download/forests/rfb_survival.pdf.

Table 3-5. Forest carbon sequestration rates for riparian forest establishment.

	MtC/ac (0 yr)	MtC/ac (45 yr)	MtC/ac/yr
Loblolly pine (Southeast) (NE-GTR Table B39)	1.7	41.9	0.9
Elm-ash-cottonwood (South Central) (NE-GTR Table B46)	1.7	41.8	0.9

2. Economic Costs

Estimated per acre costs for riparian forest establishment in Maryland were assumed to be the same as for afforestation, and were obtained from Walker et al. (2007). Costs include site preparation, labor, seedlings, and herbivore protection (Walker et al. 2007). Per-acre afforestation costs in Maryland were estimated to be $1,180 and $980 for hardwoods and softwoods, respectively. Since riparian forests were assumed to be softwoods and hardwoods in equal proportions, the weighted average cost to plant an acre of forest in Maryland was estimated at $1,055. This is a one-time cost incurred in the year of planting. Based on this information, the net present value (NPV) for this option is $27.6 million, with a levelized cost-effectiveness of $44.19/ ton CO2e (Table 3-6). As with the afforestation option above, this analysis ignores the likely economic benefits of riparian forest establishment, in terms of services such as clean air and clean water, reduced flooding, aesthetic effects, and other benefits. These benefits are typically more difficult to quantify than the tangible costs of tree planting, but they should be considered in the analysis of economic costs and benefits of riparian afforestation activity.

Table 3-6. Economic costs of riparian forest establishment

	Acres planted	Total cost	Discounted cost
2008	420	$442,660	$442,660
2009	839	$885,321	$843,163
2010	1259	$1,327,981	$1,204,518
2011	1678	$1,770,642	$1,529,547
2012	2098	$2,213,302	$1,820,889
2013	2517	$2,655,962	$2,081,016
2014	2937	$3,098,623	$2,312,240
2015	3357	$3,541,283	$2,516,724
2016	3776	$3,983,944	$2,696,490
2017	4196	$4,426,604	$2,853,428
2018	4615	$4,869,264	$2,989,306
2019	5035	$5,311,925	$3,105,772
2020	5455	$5,754,585	$3,204,368
total	38182		$27,600,122

Key Assumptions: See analysis, above.

Managing and maintaining afforested lands is covered under AFW 1. Key Uncertainties

The actual value of economic benefits of afforestation, in terms of ecosystems services such as clear water, clean air, flooding mitigation, aesthetic value, tourism, etc. thus these values are not included.

Costs of land acquisition for planting varies widely.

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Additional Benefits and Costs

Ancillary benefits from afforestation, such as avoided costs of pollution abatement are not included in the cost savings. Aesthetic improvements to barren lands accrued through returning to forest lands include increased local property values, reduce the amount and speed of run-off (reducing sedimentation, increasing water quality and enhancing soil water retention) and improved wildlife habitat.

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Feasibility Issues

Timing of implementation depends on funds and policy changes; once trees are planted it could take 6–18 years before measurable carbon sequestration is achieved.

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Concern has been expressed that there may not be sufficient acreage to meet the existing and pending offset planting requirements.

Status of Group Approval

Pending – [until MWG moves to final agreement at meeting #5 or #6]

Level of Group Support

TBD – [blank until MWG meeting #5]

Barriers to Consensus

TBD – [blank until final vote by the MWG]

AFW-4. Protection and Conservation of Agricultural Land, Coastal Wetlands and Forested Land

Policy Description

Land conservation offers an important mechanism to mitigate and adapt to climate change. Deforestation and other land-use changes account for as much as 25% of global GHG emissions. In addition, the increasing rate of sea level rise and associated erosion threaten Maryland's shoreline and associated coastal wetlands, removing another natural sink for GHGs. For these reasons and more, we should protect Maryland's green infrastructure and coastal lands. Protected forests will remain forested in perpetuity but does not preclude active management.

Maryland and its partners should map, designate, prioritize and purchase areas/property interests that provide potential retreat for wetlands and wildlife, address shoreline erosion issues and provide ancillary carbon sequestration benefits.

Policy Design

Green infrastructure is our natural life-support system—an interconnected network of natural areas and other open spaces that maintains fully functioning ecosystems, sequesters carbon dioxide, sustains clean air and water, and provides a wide array of benefits to people and wildlife. Green infrastructure planning is a systematic and strategic approach to land conservation (similar to watershed-based planning) used to develop a guide to an open space system.

Implementation for green infrastructure plans include such elements as land acquisition, conservation easements, purchase and transfer of development rights, tax credits and structures, and zoning. The toolbox also includes refining land use planning policies and funding programs to allow users of these tools—governments, nongovernmental organizations and private citizens—to more effectively protect Maryland's green infrastructure network.

Wetlands and Marshes: *(this information is repeated in AFW 3)*

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Carbon storage and methane emissions from wetlands in Maryland (and North America more broadly) are highly uncertain in these complex ecosystems. In many cases, wetlands are a natural sink for carbon but can also be a source of methane when decomposition occurs after extended highly anaerobic conditions. Other wetlands, such as salt water marshes, are different as they support carbon sequestration but emit negligible amounts of methane because sulfate in saline water suppresses the development of methane-generating organisms.

The complexities of these ecosystems make the net carbon equivalent balance (i.e. sinks less GHG outputs) for fresh water wetlands inherently difficult to measure. Salt water marshes are more straight forward and *The First State of the Carbon Cycle Report*[11] identifies a mean carbon

[11] King, A.W., L. Dilling, G.P. Zimmerman, D.M. Fairman, R.A. Houghton, G. Marland, A.Z. Rose, and T.J. Wilbanks (eds.) *The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and*

accumulation rate for conterminous United States tidal marshes as 2.2 million grams of carbon per hectare per year.

Research is necessary to reduce the uncertainties in carbon and methane fluxes in wetlands to provide better information on the appropriate management techniques and the potential for GHG emissions savings through effective management, restoration, and conservation of wetlands.

Regardless of the type of wetland or the net carbon balance, there are potential risks that significant amounts of carbon stored could be released into the atmosphere if these areas are not appropriately maintained. This highlights the need to preserve and restore these ecosystems, from both a greenhouse and local environmental perspective.

Goals: Using green infrastructure plans as a guide, leverage funds to protect agricultural lands, forestlands, wetlands and coastal areas.

Agriculture lands: Decrease the conversion of agriculture land to developed land through the protection of 1.2 million acres of productive agricultural lands, to ensure no net loss by 2020.

Forest lands: Retain existing levels of forest cover in Maryland, estimated at 2.6 million acres, past 2020 and protect an additional 250,000 acres of forest by 2020 through legal mechanisms, with more than half in areas of high value to water quality (Maryland Forest Service). The acreage protected under AFW-4 is additional to acreage already slated for protection under other programs, and thus seeks to target upland forest areas, which are at greatest risk of conversion to developed use.

Wetlands: Assess the capacity of wetland types to sequester or release carbon, then focus protection and restoration efforts on wetland types with the greatest capacity for CO_2 sequestration. Next using GIS analysis, predict losses due to climate change and set regional goal for restoration based upon predicted losses and funding availability. (not quantified.)

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Coastal lands: Protect priority areas designated for coastal wetland retreat and coastal forest lands using nonstructural shore erosion controls (i.e. living shoreline) – keeping pace with wetland, forest and critical habitat loss due to sea level rise. (not quantified)

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Timing: As described above.

Parties Involved: State and quasi-state government agencies including the Maryland Department of Planning, nonprofit organizations, foundations, and individuals.

Other: Before colonization by Europeans, Maryland was 95% forested, the other 5% being marsh around Chesapeake Bay (Besley, 1916 and Powell and Kingsley, 1980). By 2000, forest had decreased to 42.8% of land cover. Similarly, Maryland has lost 50% of its pre-settlement wetlands (Tiner and Burke, 1995). Developed land use reached 509,200 ha in 2000. The Maryland Department of Planning has projected that by 2020 urban land use will increase by

Implications for the Global Carbon Cycle. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, USA, See http://www.climatescience.gov/Library/sap/sap2-2/final-report/default.htm more than 25% from 1997 levels, and that forest cover will decrease a further 9% by 2020 from 1997 levels. Agriculture has also been projected to decrease by 9% during the same period. Approximately 31% of Maryland's 4,360-mile coastline, which encompasses the Chesapeake Bay, the Coastal Bays, and the Atlantic Coast, is currently experiencing some degree of erosion. Maryland loses ~260 acres of tidal shoreline to erosion each year. Accelerating rates of sea level rise combined with increased development along Maryland's coastline tend to prolong and exacerbate shore erosion problems.

Implementation Mechanisms

Watershed-based planning is an important tool to accomplishing the goals below.

Possibly rank Project Open Space (POS) money by GHG benefit. There should be no diversion of land conservation funds from the open space program.

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Increase the transfer tax on agriculture/forestry land transfers to non- agriculture/forestry uses. Maryland Land Preservation Taskforce suggests doubling that tax on conversion of agricultural lands to development.

Reduce or eliminate transfer taxes for continued agriculture/forestry uses.

- **Land Preservation Tax Credit – Modify Existing Income Tax Credit for Preservation and Conservation Easements (MD Code Ann §10-723)**
    - Individuals *and corporations* would be allowed to take a *larger* conservation credit for conveying land located in Maryland for such purposes as historical or conservation preservation, agricultural use, forest use, open space, and natural resource conservation. The credit pool would be capped at $100million per year and prioritized to first accept tax credits in coastal hazard areas.
        - A conservation credit is an income tax credit available to landowners who voluntarily preserve their land through the donation of a conservation easement and or fee title.
        - Landowners with little or no taxable income derive fewer benefits from tax credits than do wealthier landowners with high incomes. To address this issue the credit should be made transferable (not the case under existing law) to other taxpayers for use on Maryland State income tax returns.
    - The maximum credit would be raised to $100,000 per year with an unlimited amount eligible for transfer and use by third parties and could be carried forward for 15 years (as is the case under current law).
    - The transfer of the credit must be completed before the end of the tax year in order to use the credit for that year and must be registered with the Department of Assessment and Taxation to be valid.
    - A cap of $100 million will be placed on the first year of implementation, and will be increased each year by the percentage that the consumer price index for all urban consumers (CPI-U) exceeds the previous years CPI-U.
    - A fee of 3% of the appraised value of the donated interest will be charged on the sale of land preservation credits.

- Funds derived from this program will cover the cost of program management up to 2% with residual monies used for shoreline restoration/conservation fund.

- **CO_2 Budget Trading Program**
  - Prioritize the sequestration of carbon through land conservation or restoration by making a fixed percent of CO_2 emissions proceeds from future Maryland carbon markets exclusively available to land conservation projects.
  - Approve Subtitle 26.09 Maryland CO_2 Budget Trading Program, with above modification.

- **Blanket Authorization for Local Bond Initiatives**
  - Authorize all County governments (some are presently restricted) to approve local bond initiatives specifically for land conservation and climate change adaptation.

- **Program Open Space (POS) Targeting**
  - One of the State's key implementation tools is Program Open Space (POS), which provides dedicated funds for Maryland's state and local parks and conservation areas. Since the program began in 1969, POS funds have never distributed based upon a project's GHG benefit. Nevertheless, this should now be a prominent consideration when determining the use of these funds. In addition, given the importance of this program, there should be no diversion of funding from the POS program.

- **Extend the Next Generation Farmland Acquisition Program to Maryland Forest Landowners**
  - Through the Maryland Agriculture and Resource Based Industry Development Corp. (MARBIDCO), provide eligible forest landowners up to 70% of the easement value of a property, giving the forester equity for a loan to purchase the property.
  - The forester then has the option of finding a land preservation program to buy the development rights at a higher price within 3 years, paying back MARBIDCO and pocketing the difference. Otherwise, the state pays back MARBIDCO's investment (POS funds) and takes over the easement (Maryland Environmental Trust).

- **Others**
  - Statutory and regulatory changes to cited laws.
  - Encourage use of the easements mandated under the Forest Conservation Act for development projects, and the Forest Legacy perpetual easements for working forests.
  - Modify income tax policy regarding land conservation credits, cap credit pool to \$100mm. Maximum credit suggested is \$100m/year. *(Concept: Update Tax Credit program to be more similar to VA to incentivize land conservation.)*
  - Generate pool of money from industry off-set allowances; earmark a certain amount specifically for land conservation.
  - Encourage local bond initiatives—allow through state authorization.
  - Encourage and support right of local governments to hold taxes specifically for conservation.

- Increase the transfer tax on agriculture/forestry land transfers to non- agriculture /forestry uses. Maryland Land Preservation Taskforce suggests doubling that tax on conversion of agriculture lands to development. Reduce or eliminate transfer taxes for continued agriculture/forestry uses.

Related Policies/Programs in Place

- DNR's Greenprint Program
- Program Open Space
- Rural Legacy Program
- The Maryland Agricultural Land Preservation Foundation (MALPF)
- Maryland Environmental Trust
- Maryland Historical Trust
- Chesapeake Bay Commission 2020 goals for Maryland committed to by the Governor:
    - Retain existing levels of forest cover in Maryland, estimated at 2.6 million acres past 2020.
    - Protect an additional 250,000 acres of forest by 2020 through legal mechanisms, with more than half in areas of high value to water quality.
    - Produce rural and forest land retention guidelines based on watershed indicators by 2008 that can support requirements for forest and water protection in local comprehensive plans.

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Types(s) of GHG Reductions

CO_2: Preventing release of carbon from conversion of forests, wetlands, and agricultural lands to development. Maintain annual carbon sequestration from forest growth, thriving wetlands and productive agricultural lands. Reduce urban sprawl thus avoiding additional emissions from vehicle miles traveled.

Estimated GHG Reductions and Net Costs or Cost Savings

- **Data Sources:**

National Resource Inventory (NRI) data for Maryland

MALPF

Farm and Ranch Land Protection Program (FRPP)

U.S. Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the DOE 1605(b) Voluntary GHG Reporting Program)

USDA Forest Service Forest Inventory data statistics for Maryland, http://www.fs.fed.us/ne/global/pubs/books/epa/states/MD.htm

- **Quantification Methods:**

Agriculture Lands GHG benefit

Studies are lacking on the changes in below and above-ground carbon stocks when agricultural land is converted to developed uses. For some land use changes, carbon stocks could be higher in the developed use relative to the agricultural use (e.g., parks). In other instances, carbon stocks are likely to be lower (graded and paved surfaces). CCS assumed that the agricultural land would be developed into typical tract-style suburban development. It was further assumed that 50% of the land would be graded and covered with roads, driveways, parking lots, and building pads. The final assumption was that 75% of the soil carbon in the top eight inches of soil for these graded and covered surfaces would be lost and not replaced. The Center for Climate Strategies (CCS) assumed no change in the levels of above-ground carbon stocks.

The benefit in each year was determined by:

- determining the amount of land protected in each year by estimating the annual rate of agricultural land lost (11,813 acres per year, determined from NRI Maryland data[12]) and assuming that agricultural land protected at an increasing rate up to 2020, where it is assumed there is no net loss of agricultural land.
- multiplying the soil carbon content (assumed to be 0.017 MMtC per 1,000 acres) on the protected land by 50% (representing graded and covered areas) and by 75% (fraction of soil carbon lost);
- converting the soil carbon lost to CO_2 by multiplying by 44/12.

The GHG benefits are indicated in table 4-1. Note that the GHG benefits only include changes to below ground soil carbon and the quantification does not include emissions caused by activities associated with the various land uses (e.g., emissions from tractor activities on agriculture land or urban vehicle activity on developed land).

Agriculture Lands Cost

To estimate program costs in each year, the estimated agricultural acres protected from development was multiplied by the conservation cost. The conservation costs were assumed to the average easement acquisition cost per acre by MALPF ($5,952/acre).[13] This cost of conservation is assumed to remain constant across the policy period. It is further assumed that subsidies are available through the FRPP[14] for a 50% cost share. While the administrative structure between MALPF and FRPP has changed, it is assumed that the cost share will continue and reduce the conservation costs by 50%.[15] The resulting cost effectiveness is $87/Mt. This

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[12] The most recent NRI data available at the detailed state level is for 1982 to 1997. It is expected that data up to 2003 will be available in 2008.
[13] Average easement acquisition cost per acre FY 2007 Easements Purchased by MALPF from The Maryland Agricultural Land Preservation Foundation five-year Annual Report for FY 2003-2007 (11 January 2008), available at http://www.malpf.info/reports/AR2007Distn.pdf.
[14] The FRPP provides matching funds (up to 50%) to keep productive farm and ranchland in agricultural uses. Working through existing programs, USDA partners with State, tribal, or local governments and non-governmental organizations to acquire conservation easements or other interests in land from landowners.
[15] Until December 31, 2005, FRPP matched up to 50% of MALPF's easement value. FRPP now requires a "before-and-after" appraisal incorporating a new definition of fair market value that adjusts values for the impact of the

estimate only accounts for the direct reductions associated with soil carbon losses estimated above and does not include potentially much larger indirect benefits associated with reductions in vehicle miles traveled. The GHG benefits and program costs are summarized in Table 4-1.

Table 4-1. Acreage protected annually and associated avoided emissions and costs under policy implementation

Year	Assumed Percentage of Goal Achievement	Agriculture Acres Protected	$MMtCO_2e$ Saved	Costs	Discounted Costs
2008	8%	909	0.021	$2,704,345	$2,704,345
2009	15%	1,817	0.042	$5,408,689	$5,151,133
2010	23%	2,726	0.064	$8,113,034	$7,358,761
2011	31%	3,635	0.085	$10,817,378	$9,344,458
2012	38%	4,544	0.106	$13,521,723	$11,124,355
2013	46%	5,452	0.127	$16,226,068	$12,713,549
2014	54%	6,361	0.149	$ 8,930,412	$14,126,165
2015	62%	7,270	0.170	$21,634,757	$15,375,418
2016	69%	8,178	0.191	$24,339,102	$16,473,662
2017	77%	9,087	0.212	$27,043,446	$17,432,447
2018	85%	9,996	0.234	$29,747,791	$18,262,563
2019	92%	10,905	0.255	$32,452,135	$18,974,091
2020	100%	11,813	0.276	$35,156,480	$19,576,444
Total		**82,693**	**1.93**		**$168,617,389**

Forest Lands GHG Benefit

Carbon savings from this option were estimated from two sources: (1) the amount of carbon that would be lost as a result of forest conversion to developed uses (i.e., "avoided emissions") and (2) the amount of annual carbon sequestration potential that is maintained by protecting the forest area.

1. Avoided Emissions

Carbon savings from avoided emissions were calculated using statewide average estimates of total standing forest carbon stocks in Maryland, provided by the USFS as part of the Forest Inventory and Forecast for Maryland (Appendix XX).

Loss of forests to development results in a large one-time surge of carbon emissions. In this case, it was assumed that 100% of the vegetation carbon stocks would be lost in the event of forest

easement on adjacent parcels owned by the seller to calculate the value of the federal match. The FRPP easement valuation system creates administrative problems for MALPF because the amount of the federal match cannot be determined at the time of the offer, but only after a third appraisal is completed close to the time of settlement, increasing the difficulty of allocating funds among funding sources (MALPF five-year Annual Report for FY 2003-2007, 11 January 2008) conversion to developed uses, with no appreciable carbon sequestration in soils or biomass following development. While soil carbon may be lost on forest conversion to developed use, soil carbon loss was excluded from this analysis because soil carbon dynamics are not included in the baseline calculations for the Inventory and Forecast. A comparison of data from the American Housing Survey with land use conversion data from the Natural Resources Inventory (NRI) suggests that, on average, two thirds of the land area in residential lots is cleared during land conversion. Thus, it was assumed that, during forest conversion to developed use, 100% of the forest vegetation would be lost on 67% of the converted acreage. Using the statewide average carbon densities from the USDA Forest Service Forest Inventory and Analysis (FIA) for Maryland results, roughly 27.9 tons carbon emissions are avoided for every acre of forest preserved in Maryland.

The best currently-available data on transition into and out of the forest land category are from the FIA dataset. Based on these data, between 1986 and 1999, roughly 9,643 acres of forest were lost in Maryland annually (FIA statistics). The most recent FIA data on forestland use transition in Maryland are not reliable because an adequate number of plots have not yet been sampled to provide a statistically robust sample of forestland area. Still, the most recent inventory cycle (in 2006) does suggest a continued loss of forestland in Maryland.

To reach the goal of protecting 250,000 acres by 2020 (with 96,000 acres protected by 2012), an additional 19,200 acres would need to be protected each year between 2008 and 2012, and 19,250 acres would need to be protected between 2013 and 2020.

Table 4-2 shows the annual and total acreage targeted by the program and associated avoided emissions that would be generated between 2008 and 2020.

Table 4-2. Acreage protected annually and associated avoided emissions under policy implementation

Year	Acres Protected	Avoided Emissions ($MMtCO_2e$)
2008	19,200	1.962
2009	19,200	1.962
2010	19,200	1.962
2011	19,200	1.962
2012	19,200	1.962
2013	19,200	1.967
2014	19,200	1.967
2015	19,200	1.967
2016	19,200	1.967
2017	19,200	1.967
2018	19,200	1.967
2019	19,200	1.967
2020	19,200	1.967
Total	**250,000**	**25.545**

2. Annual Sequestration Potential in Protected Forests

A majority of the forests in Maryland are oak-hickory types (63%), with 11% in oak-pine and 10% in natural loblolly-shortleaf pine stands (USDA Forest Service, Forest Inventory and Analysis). The remaining forest land is a mix of elm-ash-cottonwood, oak-gum-cypress, maple beech-birch, and white-red-jack pine. This analysis assumed protected forests would occur in the three predominant forest types, following the proportions in the existing inventory: oak-hickory (70%), oak-pine (15%) and loblolly-shortleaf pine (15%). The calculations in this section of the analysis thus used default carbon sequestration values for these forest types (USFS GTR-343, Tables A3, A4, and A39). Average annual carbon sequestration was calculated for stand ages between 25 and 75 years, assuming that protected forests would span this age range. Average annual sequestration rate was calculated by subtracting non-soil carbon stocks in 75-year-old stands from non-soil carbon stocks in 25-year-old stands and dividing by 50 (Table 4-3). Soil carbon density was assumed constant and is not included in the calculation.

Table 4-3. Forest carbon sequestration rates in protected forests

Forest Type	MtC/ac (25 yr)	MtC/ac (75 yr)	MtC/ac/yr
Oak-Hickory (GTR NE 343 Table A3)	37.7	80.1	0.8
Oak-Pine (GTR NE 343 Table A4)	33.3	68.8	0.7
Loblolly-shortleaf pine (GTR NE 343 Table A39)	29.1	55.6	0.5

The results for annual sequestration potential under policy implementation are given in Table 4-4. Forests preserved in one year continue to sequester carbon in subsequent years. Thus, annual sequestration potential includes benefits from acres preserved cumulatively under the program.

Table 4-4. Cumulative protected acreage and annual sequestration on protected acreage under policy implementation.

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Year	Cumulative Acreage Protected	Annual Sequestration (MMtCO$_2$e)
2008	19,200	0.055
2009	38,400	0.110
2010	57,600	0.165
2011	76,800	0.220
2012	96,000	0.274
2013	115,250	0.329
2014	134,500	0.384
2015	153,750	0.439
2016	173,000	0.495
2017	192,250	0.550
2018	211,500	0.605
2019	230,750	0.660
2020	250,000	0.715
Total	**250,000**	**5.000**

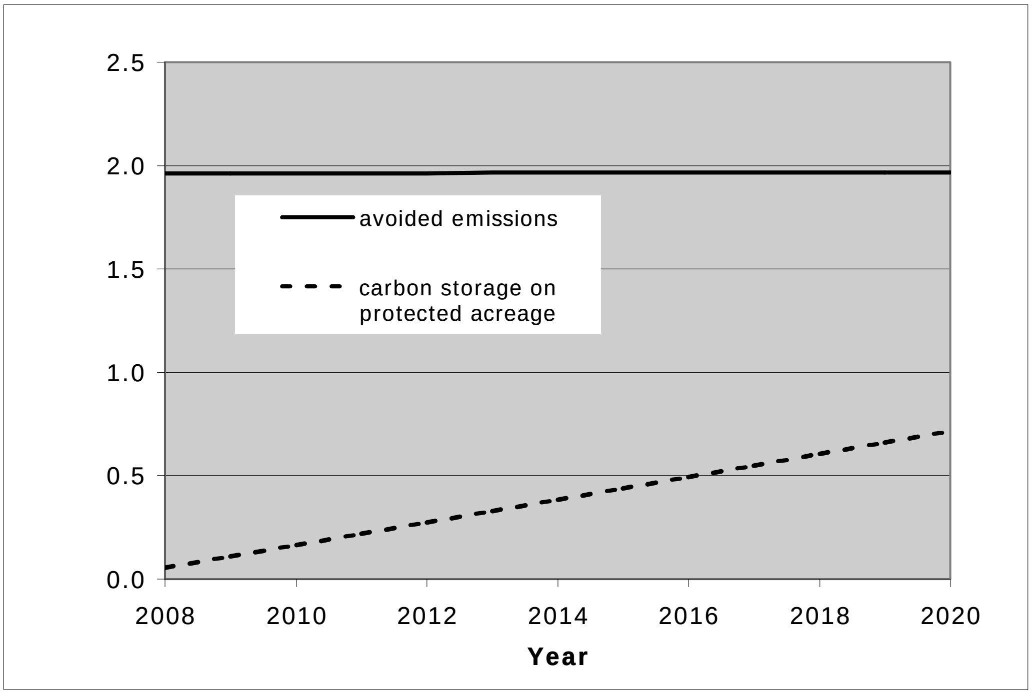
3. Overall GHG Benefit of Avoided Land Conversion

The cumulative GHG benefit of avoided forest land conversion (including avoided emissions from reduced conversion as well as annual sequestration in protected forest) was calculated in units of $MMtCO_2e$ (Table 4-5). Figure 4-1 shows the relative impact of avoided emissions and sequestration in protected acreage.

Table 4-5. Combined effect of avoided land conversion and Carbon storage on protected acreage

Year	$MMtCO_2e/yr$
2008	2.017
2009	2.072
2010	2.126
2011	2.181
2012	2.236
2013	2.296
2014	2.351
2015	2.406
2016	2.461
2017	2.517
2018	2.572
2019	2.627
2020	2.682
Total	**30.544**

Figure 4-1. Relative impact of forest protection and carbon sequestration on protected acreage



Forest Lands Cost
Economic costs of protecting forest land were assumed to be the per-acre one-time cost of purchasing conservation easements, at $5,952/acre. This estimate is the recorded average "acquisition cost" in 2007 for easements obtained in Maryland via the MALPF (see Agriculture Land Costs, above).

Net economic costs of protecting forestland are presented in Table 4-6. Discounted costs were calculated using a 5% discount rate, with a total NPV of $1128.7 million. The cost-effectiveness of this option is $36.95/Mt CO_2e avoided.

Table 4-6. Economic costs of protecting forestland under AFW-4

Year	Total Cost	Discounted Costs
2008	$114,278,400	$114,278,400
2009	$114,278,400	$108,836,571
2010	$114,278,400	$103,653,878
2011	$114,278,400	$98,717,979
2012	$114,278,400	$94,017,122
2013	$114,576,000	$89,773,294
2014	$114,576,000	$85,498,375
2015	$114,576,000	$81,427,024

2016	$114,576,000	$77,549,547
2017	$114,576,000	$73,856,711
2018	$114,576,000	$70,339,725
2019	$114,576,000	$66,990,214
2020	$114,576,000	$63,800,204

- **Key Assumptions:**

The cost of conservation is assumed to remain constant across the policy period.

Key Uncertainties

TBD – [as needed and approved by the TWGs]

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Additional Benefits and Costs

TBD – [as needed and approved by the TWGs]

Feasibility Issues

TBD – [as needed and approved by the TWGs]

Status of Group Approval

Pending – [until MWG moves to final agreement at meeting #5 or #6]

AFW-5. "Buy Local" Programs for Sustainable Agriculture, Wood, and Wood Products

Policy Description

Promote the sustainable production and consumption of locally produced agricultural goods, which displace the consumption of those transported from other states or countries. GHG reductions occur from reduced transportation-related emissions, reduced production-related emissions and enhanced forest health.

Using local wood for construction, furniture or other value-added wood products will enhance local economies while reducing carbon emissions by lowering transportation distances and sequestering carbon in those products.

The use of wood products displaces GHG emissions associated with processing high-energy input materials such as steel, plastic and concrete.

Increased demand for local wood products increases opportunities for forest management treatments that improve forest health and sustainability, thereby improving sequestration and nutrient absorption.

Policy Design

Put leverage on local governments to be part of the solution by ensuring that zoning does not preclude intelligent, sustainable uses that support this objective, such as constraining local value-add mills or limit location/participation in local markets.

Goals:

Farmer's Market: Increase local farmer's markets in Maryland by 25% by 2015 and 50% by 2020.

Local Produce: Of the food Marylanders consume, 80% would be grown or produced locally by 2050.

Locally Grown and Processed Lumber: The amount of locally grown and processed lumber would displace imported wood by 20% by 2015 and 50% by 2050.

Timing: Startup in 2009 and ramp up to higher levels in 2015 and 2020, consistent with goals.

Parties Involved: Agricultural and wood product primary producers such as Maryland farmers, lumber mills, farmer's market associations and promoters; value-added producers such as Maryland caterers, producers of packaged food for retail, furniture makers, construction businesses, wholesalers and retailers of construction and do-it-yourself products, architects and designers; applicable trade associations, MDA, DNR, LEED certification entities.

- **Other:** As needed, identify incentives that encourage the sustainable growing and harvesting of local agricultural and wood products.

Implementation Mechanisms

Specific incentives recommended:Care must be taken to ensure that the wood and agricultural products are sustainably harvested and produced to create a net carbon sequestration and reduction in emissions.

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Do we want to recommend a certification program for optional, but recommended, use for forest and ag products?

- Maryland has been a LEED (a rating and certification system for green building) leader, but hasn't been given credit for wood products, especially local woods as contributing to energy efficiency and carbon emission reductions. This is an issue in several states. Maryland should push for LEED to include points for the use of wood, particularly local sustainably grown wood.
- Encourage the creation of value-added products from local woods in lieu of shipping raw materials from long distances.

Do we need an education/outreach program to producers as well as consumers?

Related Policies/Programs in Place

MDA has recently been revitalized and is actively promoting a Buy Local program.

Types(s) of GHG Reductions

CO_2: Extending carbon sequestration in durable wood products and wood construction. Maintaining carbon sequestration in healthy forests. Avoidance of emissions through reduced transportation miles. Avoidance of emissions through reduced use of high-energy input construction materials.

Estimated GHG Reductions and Net Costs or Cost Savings

Data Sources:

All data sources, methods and assumptions are based on the Iowa study cited below, and were scaled to Maryland using state population adjustments. The study analyzed the feasibility and effects of shifting transportation distance and mode.

- **Quantification Methods:**

Farmer's Market GHG Benefits
The GHG benefits for the Maryland option are based on a study from Iowa State University[16] which compared miles traveled, fossil fuel used, and CO_2 emitted in the transport sector of several food systems. The study estimated the fuel use and the CO_2 emissions for transporting (from farm to point of sale) 10% of 28 different fresh produce items using three different food systems: conventional, regional, and local (which includes farmer's markets).

[16] Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and GHG emissions. Leopold Center for Sustainable Agriculture, 209 Curtis Hall Iowa State University Ames, Iowa 50011-1050 Website: http://www.leopold.iastate.edu/