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Table x.
Agriculture, Forestry, and Waste Management Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions (MMtCO ₂ e)			Net Present Value 2007-2020 (Million \$)	Cost-Effectiveness (\$/tCO ₂ e)	Level of Support
		2010	2020	Total 2007-2020			
	AGRICULTURE, FORESTRY, AND WASTE MANAGEMENT						
AFW-1	Programs to Support Local Farming/Buy Local						TBD
AFW-2	Agricultural Soil Carbon Management Programs						TBD
AFW-3	Manure Management Methods to Achieve GHG Benefits						TBD
AFW-4	Preserve Open Space/Agricultural land						TBD
AFW-5	Forestry Programs to Enhance GHG Benefits						TBD
AFW-6	Increased Forest Biomass Energy Use						TBD
AFW-7	Forest Protection – Reduced Clearing and Conversion to Non-forest Cover						TBD
AFW-8	Expanded Use of Durable Wood Products (especially from VT sources)						TBD
AFW-9	Advanced/Expanded Recycling and Composting						TBD
AFW-10	Programs to Reduce Waste Generation						TBD
AFW-11	Waste Water Treatment – Energy Efficiency Improvements						TBD
AFW-12	In-State Biofuels Production						TBD
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS						
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)						
	SECTOR TOTAL PLUS RECENT ACTIONS						

AFW-1. Programs to Support Local Farming/Buy Local

Mitigation Option Description

Programs that promote the production, distribution and consumption of locally-grown food products reduce transportation and manufacturing emissions by offsetting the consumption of products with higher embodied energy. Food products consumed in the U.S. can travel thousands of miles before reaching a grocery or clothing store in the form of a final product (a typical food product can travel over 1,500 miles and change hands dozens of times). Increasing the percentage of locally grown food consumed in Vermont will reduce fossil fuel use and its associated GHG emissions.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

Estimated GHG Savings and Costs per MtCO₂e

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-2. Agricultural Soil Carbon Management Programs

Mitigation Option Description

Use of conservation tillage/no-till and other soil management practices can increase the level of organic carbon in the soil, which sequesters carbon dioxide. In addition, some practices lower fossil fuel consumption through less intensive equipment use. Other practices, such as the application of bio-char can also increase the level of soil carbon and improve the soil. This option is designed to increase the acreage using soil management practices that lead to higher soil carbon content.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-3. Manure Management Methods to Achieve GHG Benefits

Mitigation Option Description

The methane emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. Methane and nitrous oxide emissions can occur at several different places in the manure management process. Management techniques aimed can reduce GHG emissions and, with energy recover, offset fossil-based energy. This option covers producer incentives to adopt programs to increase the number of methane capture and energy recovery projects or other manure management techniques that reduce methane and nitrous oxide emissions.

Mitigation Option Design

- **Goals:** Digest half of dairy cattle manure by 2028; Compost 50% of the poultry and livestock manure produced on farms by 2028; Implement nutrient management strategies which meet the NRCS Technical Practice Code 590 on 90% of the land which receives manure or processed waste water by 2028.
- **Timing:** Increase the anaerobic digestion from five (5) percent (in operation and under construction) to 15 percent of the dairy cattle manure in Vermont over the next five years (2012). By 2028, digest 50 percent of the dairy cattle manure in Vermont; Increase the percent of manure composted on poultry and livestock farms to 25% by 2012 and to 50% by 2028; Implement nutrient management plans on 75% of the lands receiving manure and processed wastewater by 2012 and on 90% of this land base by 2028.
- **Coverage of parties:**
- **Other:** Anaerobic digestion of half of Vermont's dairy manure could produce 15 megawatts of electric generation and 350 billion Btu's of heat energy per year.

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-4. Preserve Open Space/Agricultural Land

Mitigation Option Description

Reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass can be higher in agricultural lands than in developed land uses. Policies are needed to preserve working farms and forests (see AFW-7) from unwise and unplanned development.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-5. Forestry Programs to Enhance GHG Benefits

Mitigation Option Description

Direct the products of forest management to the highest value markets that currently exist. Use of these products in durable wood products (building materials, furniture, etc.) serves as a long-term method for storing carbon. Increase the growth and yield of production from sustainably-managed forest resources through site preparation, competition control, thinning, fertilization, and improved genetics. These practices will increase carbon dioxide sequestration rates. Use of biomass waste from forestry programs for energy purposes is covered under AFW-6.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**
- **Implementation Mechanisms**

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-6. Increased Forest Biomass Energy Use

Mitigation Option Description

The goals of this option are to direct unmarketable logging residue, culls, and saplings from the forest products industry and other biomass from forest management programs to the appropriate processing centers for energy purposes (electricity, heating or liquid fuels). Offsetting fossil fuel use with biomass energy reduces GHG emissions.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-7. Forest Protection – Reduced Clearing and Conversion to Non-forest Cover

Mitigation Option Description

Reduce losses of forested lands and their carbon sequestration potential to development or poor forest management. Developed areas contain lower amounts of biomass and its associated carbon. These developed areas also sequester less carbon dioxide than forested areas.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO₂e

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-8. Expanded Use of Durable Wood Products (especially from VT sources)

Mitigation Option Description

This option covers programs designed to increase the use of durable wood products in VT with an emphasis on wood products produced in VT. Wood products have lower embodied energy than many types of building materials (e.g. cement, steel). To the extent that wood products displace products with higher embodied energy, GHG emissions can be reduced.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-9. Advanced/Expanded Recycling and Composting

Mitigation Option Description

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantity of materials being landfilled reduces future landfill methane emissions potential, while recycling reduces emissions associated with the manufacturing of products from raw materials. Use of waste materials as a fuel source can further reduce emissions by offsetting fossil-based energy sources.

Mitigation Option Design

- **Goals:** Increase per capita diversion 50% from 2005 actual diversion rate (30%).¹
- **Timing:** 25% by 2012; 50% by 2028.
- **Coverage of parties:** Federal, state and municipal government, private solid waste and recycling service providers, commercial, industrial and institutional waste generators, Vermont Agency of Natural Resources Solid Waste Division.
- **Other:** Per capita diversion as calculated by ANR Solid Waste Division.

Implementation Mechanisms

Working together in further defining, developing, implementing, and promoting sustainable recycling practices will require an in depth understanding of the cost effectiveness and environmental benefits of recycling.

- Develop advanced recycling infrastructure so that the entire state is able to participate in single stream recycling. Currently only the Chittenden County area is served by single stream recycling.
- Develop an incentive/rewards based recycling infrastructure, coupled with single stream hardware infrastructure, to encourage all Vermont residents and businesses to divert recyclable materials from the waste stream (VT's diversion rate is essentially unchanged in the last several years (2002: 30%, 2003: 31%, 2004: 29%, 2005: 30%²) This

¹ Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm

² Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

incentive/reward system could be expanded to include end of life electronics and promote the recovery, reuse and recycling of all obsolete electronic equipment.

- Develop additional processing capacity across the state for processing organic wastes and expand the collection of commercially generated organic waste materials.
- Develop a used clothing recycling program (curb-side and rural drop off model) for used clothing. Approximately 6% of the municipal solid waste stream is used clothing.³

Develop an incentive/rewards based recycling infrastructure specifically for construction and demolition material to encourage all Vermont residents and businesses to divert recyclable construction materials from the waste stream (2005 C&D disposed of 99,654 tons).⁴

Related Policies/Programs in Place

- Vermont Environmental Assistance Division – Business Environmental Partnership Program
- Vermont Food Rescue/Waste Division Grants for Organic Diversion
- Vermont Technology and Information Transfer and Exchange Program
- Vermont Construction & Demolition Waste Reduction Assistance Program

Types(s) of GHG Reductions

Net reduction in CO₂ and methane emissions.

CO₂: Upstream Energy Use Reductions – The energy intensity of a manufacturing is generally less using recycled feedstocks than from using virgin feedstocks.

Methane: Diverting organic wastes from landfills will result in a decrease in methane gas releases from landfills.

Estimated GHG Savings and Costs per MtCO₂e

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

³ U.S. EPA “Waste Wise” retrieved from www.epa.gov/epaoswer/non-hw/reduce/wstewise/pubs/overview.pdf.

⁴ Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Summary, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm.

Additional Benefits and Costs

TBD

Feasibility Issues

- Post consumer organic waste diversion.

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-10. Programs to Reduce Waste Generation

Mitigation Option Description

Institute programs to reduce waste generation at the source to reduce downstream emissions at the waste management site and for transporting these materials to the site. Reducing waste generation can also reduce the emissions associated during manufacturing of the original products.

Mitigation Option Design

- **Goals:** Reduce current annual growth in municipal solid waste generation 50% below 2005 actual rate of 5.40 pounds per person per day.⁵
- **Timing:** 25% by 2012; 50% by 2028
- **Coverage of parties:** Residential, commercial, industrial and institutional waste generators, Vermont Agency of Natural Resources Solid Waste Division
- **Other:**

Implementation Mechanisms

The policy should aim to develop accessible, cost effective and sustainable policies, strategies and educational/media campaigns that will promulgate cultural and behavioral changes across the state with the ultimate goal of reducing the amount of waste generated. The policy should reflect the principles of the waste hierarchy and reduce the generation of all waste.

- Develop prototype residential and commercial waste prevention programs that will validate costs savings realized by the waste prevention.
- Develop a communication portal that will keep all constituents apprised of waste reduction/minimization initiatives and actively promote waste minimization efforts, including the results of prototype programs and specific case studies.
- Develop sector specific waste minimization strategies (schools, hotels, hospitals, restaurants, retail, banks, etc.). Develop these strategies in collaboration with other organizations and the local community.
- Develop an assistance program to provide engineering support to businesses to: 1) reduce product packaging and shipping materials 2) select product packaging and shipping materials that are highly recyclable.

⁵ Vermont, Agency Natural Resources, 2005 Solid Waste Generation Report, Table 2, retrieved from www.anr.state.vt.us/dec/wastediv/solid/DandD.htm

- Encourage manufacturers to provide end-of-life management solutions that reduce the environmental impact of waste

Develop and implement a green purchasing program for all state operations, and use that program as a model and encourage adoption of that model by all municipalities and businesses.

Related Policies/Programs in Place

- Vermont Department of Environmental Conservation “Beyond Disposal & Recycling Waste Prevention Stakeholders Forum”
- Vermont Agency of Natural Resources Environmental Assistance Office Partnership

Types(s) of GHG Reductions

Net reduction of CO₂ emissions.

Estimated GHG Savings and Costs per MtCO₂e

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-11. Waste Water Treatment – Energy Efficiency Improvements

Mitigation Option Description

Energy efficiency programs at wastewater treatment plants can reduce GHG emissions by reducing consumption of electricity to run pumps, fans, and other electrical equipment. Included in this option is a review of the potential for installing anaerobic digesters for biosolids and subsequent use of the methane as an energy source for generating electricity (e.g. using internal combustion engines or microturbines).

Mitigation Option Design

- **Goals:** Develop an energy conservation, management and efficiency plan to increase energy efficiency of plant operations by 25%; Use wastewater digester gas to produce energy where feasible
- **Timing:** 15% by 2012; 25% by 2028
- **Coverage of parties:** Municipal and private/investor-owned water and wastewater treatment operators, Vermont Agency of Natural Resources Wastewater Treatment Division
- **Other:**

Implementation Mechanisms

An evaluation of the potential for energy efficiency and energy production improvements in municipal and private/investor-owned water and wastewater treatment sector is needed. Energy costs can account for 30% of the total operation and maintenance costs of WWTPs. WWTPs account for 3% in electric load in the United States.⁶

Goals of the assessment are to:

1. Quantify the energy consumed in Vermont's municipal and private/investor-owned water and wastewater treatment sector annually, to establish a baseline for the sector.
2. Assess the potential for energy savings for the sector.
3. Assess the potential for energy production using digester gas (in anaerobic plants).

Near-term opportunities for energy savings:

- Lighting retrofits from T12 systems to T8;

⁶ EPA, Wastewater Management Fact Sheet – Energy Conservation, July 2006.

- Heating retrofits from electric heat;
- Installation of high-efficiency influent and effluent pumps, high-efficiency motors and variable frequency drives;
- Evaluate the costs and benefits to second-stage activated sludge mixing and aeration;
- Identify opportunities for peak demand reduction and optimizing load profiles.

Mid-term opportunities for energy savings:

- Co generating electricity and thermal energy on-site; capturing and using anaerobic digester gas.

Related Policies/Programs in Place

Net reduction in CO₂ emissions.

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

AFW-12. In-State Biofuels Production

Mitigation Option Description

This option covers incentives needed to increase biodiesel and ethanol production in Vermont. Use of biodiesel offsets the consumption of diesel fuel produced from oil (fossil diesel). Since biodiesel has a lower GHG content than fossil diesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. Also, feedstocks for biodiesel production (e.g. vegetable oils) produced from GHG-superior sources than the current dominant feedstock (soybean oil) can produce additional significant reductions.

This option also seeks to offset fossil fuel use (gasoline) with in-state production of ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Incentives are needed for the production of ethanol from crops, forest sources, animal waste, and municipal solid waste.

Mitigation Option Design

- **Goals:**
- **Timing:**
- **Coverage of parties:**
- **Other:**

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

TBD

Estimated GHG Savings and Costs per MtCO_{2e}

TBD

- **Data Sources:** TBD
- **Quantification Methods:** TBD
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD