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Brief Descriptions of Catalog Items
Agriculture, Forestry, and Waste Management
Technical Work Group

This document provides brief descriptions of the policy options contained in the corresponding Technical Work Group (TWG) Catalog of State GHG Reduction Policy Actions. The catalog and these brief descriptions will be developed more fully during the climate planning process in Kentucky.

AFW-1. AGRICULTURE & FORESTRY—PRODUCTION OF FUELS AND ELECTRICITY

1.1 Expanded Use of Biomass Feedstocks for Electricity, Heat, and Steam Production

This option would increase the amount of biomass available from forests for generating electricity and displacing the use of fossil energy sources. Considerations should include the sustainability of biomass, the environmental impacts from biomass harvesting, and the transportation costs of moving biomass from the source location to the processing location. The Governor's Task Force on Biomass and Biofuels (available at energy.ky.gov/biomass) may serve as a resource for this option. This option is related to AFW 8.2 (Expanded Use of MSW and Yard Waste Biomass Feedstocks for Electricity, Heat, and Steam Production), which uses municipal solid waste as an energy feedstock.

1.2 In-State Liquid/Gaseous Biofuels Production for Stationary and Mobile Applications

This option would increase production of ethanol, biodiesel, or other liquid/gaseous biofuels from agriculture and forestry feedstocks (raw materials) to displace the use of fossil fuel in both stationary applications (such as biodiesel for electricity plants) and mobile applications (such as transportation fuels). For example, cellulosic ethanol feedstocks and production systems that use renewable fuels lower the embedded carbon content of ethanol. Increased production and consumption of in-state biofuels will likely provide the highest benefits. Considerations should include the sustainability of biomass, the environmental impacts from biomass harvesting, and the transportation costs of moving biomass from the source location to the processing location. The Governor's Task Force on Biomass and Biofuels (available at energy.ky.gov/biomass) may serve as a resource for this option. Note that this option is related to AFW-8.7 (Waste Management Feedstocks for Liquid/Gaseous Fuels Production for Stationary and Mobile Applications).

1.3 Improved Energy Capture From Wood and Biomass Combustion

This option would reduce emissions and increase heat efficiency from bio-feedstock-fed heat sources, such as wood-burning stoves and furnaces and using pyrolysis ovens, and would continue to advance the biomass heating industry.

1.4 Improved Commercialization of Biomass Conversion Technologies

This option would improve the rate of technology development and market deployment of biomass conversion technologies including biomass gasification combined-cycle, pyrolysis, and plasma arc technologies. These technologies expand the application of renewable fuels derived from biomass. A range of renewable products can be developed from these processes, including gaseous and liquid fuels, biochar, chemical products, and methane to methanol. Existing processes include waste combustion and energy recovery (as electricity, steam, or both) or ethanol plants using co-products for heating and drying, rather than relying on outside energy sources.

1.5 Integrated Bioenergy Research and Production

This option would integrate electricity from anaerobic methane digestion of manure, with production of by-products (e.g. biodiesel and ethanol), and would pyrolysize biomass to create energy and by-products (e.g., syngas, bio-oil and biochar).

1.6 Expanded Production/Use of Bio-based Materials and Chemicals

This option would expand the production and use of bioproducts, such as corn-based plastics through applied research, expanding production and markets. It would also increase the amount of renewable products and chemicals produced from bio-feedstocks, including building materials that reduce greenhouse gas (GHG) emissions over conventional petroleum-based products.

1.7 Manure Digesters/Other Waste Energy Utilization

This option would reduce the amount of methane emissions from livestock manure by installing manure digesters on livestock operations. Energy from the manure digesters is used to create heat or power, which offsets fossil fuel-based energy production and the associated GHG emissions. This option may consider new technologies as well, such as plasma arc technology.

Integrating methane digesters into agricultural operations could generate energy from waste on an individual or community basis.

AFW-2. AGRICULTURE—LIVESTOCK AND RANGE MANAGEMENT

2.1 Manure Management—Manure Utilization

This policy may include manure capture, management, and utilization. Manure management practices that reduce GHG emissions associated with manure handling and storage can include (but

are not limited to) manure composting (to reduce methane emissions), manure crusting, addition of additives to decrease the amount of nutrients lost, and improved methods for application to fields (for reduced nitrous oxide [N_2O] emissions). Application improvements include incorporation into soil instead of surface spraying or spreading.

Implementation of digester and energy recovery projects at concentrated animal feeding operations (CAFOs) can reduce methane emissions to utilize the energy to displace fossil fuels. The utilization of collection and control equipment, such as biofilters at CAFOs, can reduce methane emissions. Increasing the area over which manure is deposited can reduce methane emissions, since the manure is more likely to be decomposed aerobically than anaerobically.

2.2 Changes in Animal Feed

Livestock emit methane directly as a result of digestive processes (enteric fermentation). Research suggests that changes in the energy content of feed and other dietary changes can reduce methane emissions from enteric fermentation. Optimizing nitrogen (protein) utilization in the feed can reduce nitrogen levels in the manure, which in turn reduces the potential for N_2O emissions.

2.3 Rotational Grazing/Improve Grazing Crops and/or Management

Heavy grazing can cause significant soil disturbance and result in carbon losses from soils. Rotational grazing where animals are moved from field to field on a regular basis reduces soil disturbance and maintains soil carbon levels. Both rotational grazing and increased pasturing can improve plant vigor and enhance soil carbon levels.

2.4 Mitigation of Carbon Sequestration Loss and GHG Emissions From Crop or Grass Wildfires

Naturally occurring wildfires at historic frequencies and intensities are important for maintaining grassland health. However catastrophic fires can cause significant emissions and lower the soil carbon sequestration potential for some time. Programs to reduce the potential for catastrophic wildfire will help vegetation and soil to sequester carbon and resist invasion by less desirable, and more fire-prone vegetation. Note that this option may have overlap with AFW-2.5, below, but will focus on separate practices.

2.5 Mitigation of Carbon Sequestration Loss and GHG Emissions From Prescribed/Controlled Burning of Crop Residues or Grassland Residues

This option focuses on prescribed or controlled fires on cropland or grassland. Its implementation may include encouraging best practices in prescribed and controlled fires to minimize inordinate destruction of biomass and mitigate excessive GHG emissions. Note that this option may overlap with AFW-2.4, above, but will focus on separate practices. There is a Prescribed Fire Council in Kentucky that may serve as a resource for this policy (http://www.prescribedfire.net/state-councils).

AFW-3. AGRICULTURE—CROP PRODUCTION

3.1 Soil Carbon Management

The amount of carbon stored in the soil can be increased by the adoption of such practices as conservation, no-till cultivation, and crop rotation. Reducing summer fallow and increasing winter cover crops are complementary practices that reduce the need for conventional tillage. In addition, the application of biochar (i.e., charcoal) may also increase soil carbon content and stabilize soil carbon. By reducing mechanical soil disturbance, these practices reduce the oxidation of soil carbon compounds and allow more stable aggregates to form. Other benefits include reduced wind and water erosion, reduced fuel consumption, improved wildlife habitat. This policy option would encourage soil productivity and carbon sequestration through the use of biochar, winter overcrops, and practices, such as crimping/rolling.[1]

Note that Kentucky may lead the country in no-till agriculture. Kentucky farmers have made a considerable shift to no-till agriculture in the last decade. Consequently this option may have limited potential in Kentucky compared to other states.

3.2 Nutrient and Water Management

This option would improve the efficiency of fertilizer use and other nitrogen-based soil amendments through implementation of management practices and Generally Accepted Agriculture Management Practices (GAAMP). Excess nitrogen not metabolized by plants can leach into groundwater and/or be emitted to the atmosphere as N_2O. Better nutrient utilization can lead to lower N_2O emissions from runoff.

This option would also improve the efficiency of water use through implementation of best management practices and GAAMP. Excess water can lead to nitrogen runoff, with subsequent emission to the atmosphere as N_2O. Managing and improving water consumption and nutrients spread on crops will minimize loss of carbon from the soil. Reduced water consumption can result in lower energy use for water pumping. Also, improved drainage on agricultural lands prevents ponding, which could lead to anaerobic soils and GHG emissions (methane).

3.3 Technology Improvements to Increase Efficiency

New technologies and cultivation methods have the potential to reduce GHG emissions when fossil fuel or electricity consumption can be reduced. Auto-steer guidance systems are an example, as is

[1] "Cover crop rolling is an advanced no-till technique. It involves flattening a high-biomass cover crop to produce a thick, uniform mat of mulch. A cash crop is then no-tilled into the mulch. If the right kind of roller is used on the right cover crop at the right time, the rolling process itself will kill or partially kill the cover crop." From Introduction to cover crop rolling and the VA/USDA crimper roller demonstration projects, 2006, United States Department of Agriculture, available at ftp://ftp-fc.sc.egov.usda.gov/VA/Technical/conservation_planning/Crop_Agr/VA.Roller.FS.Sept.06.III.pdf.

auto-swath technology, which uses global positioning system (GPS) technology to automatically turn the spray boom sections on or off when coming to an area of the field that has been sprayed or needs to be sprayed. Auto-swath technology can be used for planting, fertilizing, and other operations. On odd-shaped fields, it can result in a 3%–5% savings. See http://www.agleader.com/products.php?Product=directcommand_l.

Variable-rate fertilizing and liming are also becoming more popular among farmers. The farmer has a local co-op grid sample the field, and then variable rate technology applies the fertilizer or lime only in the areas of the field that need it. This approach can result in a 50%–60% reduction in the amount of lime or fertilizer needed. See http://www.agleader.com/products.php?Product=directcommand_g.

As another example, GreenSeeker normalized difference vegetation index (NDVI) is a promising new technology that is still in its early testing stages. A farmer applies 50%–70% of his nitrogen at planting and then, in season, uses GreenSeeker to apply what the plant needs when it is growing. This efficient technology reduces the over-application of nitrogen. See http://www.ntechindustries.com/greenseeker-RT200.html.

Improvements may also encompass newer machines with better fuel efficiency, larger planters and combines, and genetically modified seed. Note that this option has a similar counterpart in AFW-8.1 (Advanced MSW Reuse, Recycling, and Organic Waste Management Programs).

3.4 Biotechnology Applications for Greenhouse Gas Mitigation

This option would improve research in and utilization of drought-resistant, flood-resistant, and pest-resistant crop varieties.

3.5 Perennial Crop Production

This option would encourage the planting of perennial crops, which reduces tillage, reduces planting costs and related equipment use and soil compaction, and typically reduces water consumption.

AFW-4. AGRICULTURE—LAND-USE CHANGE

4.1 Land-Use Management That Promotes Grassland Cover

This option would convert marginal agricultural land used for annual crops to permanent cover—such as grassland/rangeland, orchard, or forest—where the soil carbon and/or carbon in biomass is higher under the new land use. It includes opportunities to keep Conservation Reserve Program lands covered in perpetuity.

Increased demand for corn-based ethanol and biodiesel feedstocks can act as an incentive for converting grassland to cropland. This option would adopt mechanisms to prevent these acres from returning either to conventionally tilled production or to suburban/urban development.

4.2 Preserve Open Space/Agricultural Land

This option would reduce the rate at which agricultural lands are converted to developed uses, while protecting private property rights and responsibilities. This retains the above- and below-ground carbon on these lands, as well as their carbon sequestration potential. Transportation emissions will be reduced indirectly through more efficient development and lower vehicle use. Agricultural land conversion may be prevented through conservation land grants and conservation easements facilitated through nonprofit land-preservation organizations.

4.3 Prioritize Environmental Remediation Actions for GHG Benefits

This option would place higher priority on reclamation and remediation actions that improve the uptake of carbon dioxide and reduce GHG emissions, such as revegetation of disturbed sites with site-appropriate cover crops or native vegetation. A relevant example in Kentucky is the revegetation of mining areas.

4.4 Preserve and Expand Wetlands for Carbon Sequestration

This option would preserve and expand wetlands to increase biodiversity and improve carbon sequestration.

4.4 Increase Productivity of Reclaimed Lands

This option focuses on converting reclaimed lands, such as previously mined surface mines, to agricultural uses. These uses may include planting, grazing, biomass production for energy feedstocks, etc.

AFW 5. AGRICUTLURE—FARMING PRACTICES

5.1 Increase On-Farm Energy Production and Efficiency

This option would encourage adoption of practices and equipment that reduce on-farm emissions through efficiency and energy production. Renewable energy can be produced and used on site at agriculture operations. Examples of practices and technology include using tractors with variable-speed transmissions to reduce fuel consumption; installing solar or wind power; using hydro-powered generators for irrigation; converting diesel farm equipment to liquefied natural gas, compressed natural gas, or hybrid technology; increasing on-farm use of biofuels and other renewables; expanding farm energy audit programs; and updating machinery, equipment, and engines to reduce carbon dioxide (CO_2)emissions by displacing the use of fossil-based fuels.

5.2 Organic Farming

This option would promote organic farming practices that reduce GHG emissions. These practices may include implementing lower-intensity practices, reducing use of pesticides and fertilizer that can offgas GHGs, adding carbon-rich compost to soils, and reducing tillage, all resulting in higher soil carbon Note that not all organic farming systems or crops will reduce GHG emissions.

5.3 Programs to Support Local Farming/Buy Local Programs

This option would promote the production and consumption of locally produced agricultural goods, including transportation and heating fuel and plastics, which displace the consumption of goods transported from other states or countries. GHG reductions occur from reduced transportation-related emissions.

This option would also encourage increased beneficial agricultural uses and buying local programs to meet the food needs of residents and institutions.

5.4 Promotion of Urban Agriculture

This option would promote participation in urban agriculture programs that reduce GHGs by sequestering carbon and reduce cooling costs by mitigating urban heat islands. It would also promote all forms of urban agriculture and intensification of plant density in urban settings through community gardens, backyard gardens, and green roofs. This policy would also promote vegetation on vacant or abandoned lands. Urban agriculture programs also reduce transportation-related emissions by reducing food miles for urban consumers. Urban agriculture policies need to be sensitive to greenbelt taxing issues.

5.5 Promotion of Farming Practices That Achieve GHG Benefits

This policy serves as an umbrella that can cover a variety of farming practices. It would provide incentives to farmers for using production processes that achieve net GHG benefits, such as biotech crops or some farming practices that can reduce GHG emissions compared with conventional farming (e.g., use of no-till cultivation and fewer chemical inputs). This policy may include sustainable agriculture practices, such as conversion of mechanized farm equipment to animal-powered farm equipment, and may encourage use of appropriately sized farming equipment.

AFW-6. FORESTRY—BIOMASS PROTECTION AND MANAGEMENT

6.1 Forest Protection—Reduced Clearing and Conversion to Non-forest Cover

Much of the carbon stored in forest biomass and soils can be lost as a result of land-use conversion. This option would reduce the rate at which existing forests are cleared. Easements, conservation programs, improved markets for timber and non-timber forest products, and payment for ecosystem services are some mechanisms that may be used. Implementation practices may also include

education programs and technical and financial assistance for the 467,000 private forest landowners in Kentucky, so they will be more willing to manage their forests.

6.2 Urban Forestry

This option would maintain and improve the health and longevity of trees in urban and residential areas to protect and enhance the carbon stored in tree biomass. Indirect emission reductions may also occur by reducing heating and cooling needs as a result of planting shade trees. This option would also promote software programs that can be used by cities and communities to track urban forestry. The option needs to be sensitive to greenbelt taxing issues.

6.3 Reforestation of Understocked Forest Land

This option would re-establish trees, at appropriate spacing, on forested land that is currently understocked; interplant stands that are currently thinner than carrying capacity to increase biomass and diversify age classes; avoid planting monocultures to minimize the risk of insects and disease, while increasing the habitat value for wildlife and overall biodiversity; Favor the planting of native trees appropriate to habitat type and local climate conditions; and consider future climate trends and plant species most able to adapt to and thrive with changing conditions.

6.4 Afforestation and/or Restoration of Non-forested Land

This option would establish forests on land that has not historically been forested (e.g., agricultural land—"afforestation"), and promote forest cover and associated carbon stocks by regenerating or establishing forests in areas with little or no present forest cover ("reforestation"). In addition, it would implement such practices as soil preparation, erosion control, and stand stocking to ensure conditions that support forest growth. This policy can include forestation of previously mined surface mines as well as unforested riparian areas.

6.5 Forest Management for Carbon Sequestration

This policy focuses on forest management activities that promote forest productivity and increase the rate of CO_2 sequestration in forest biomass and soils and in harvested wood products. Practices may include increased stocking of poorly stocked lands, age extension of managed stands, thinning and density management, fertilization and waste recycling, expansion of short-rotation woody crops (for fiber and energy), expanded use of genetically preferred species, modified biomass removal practices, fire management and risk reduction, and pest and disease management. This policy would also encourage the use of native species and noninvasive species, and promote biomass removal practices to ensure forests and woodland regeneration and minimize soil loss.

6.6 Mitigation of Forest Carbon Sequestration Loss and Emissions Due to Wildfire

Programs that reduce the potential for and severity of wildfire also reduce GHG emissions by lowering the forest carbon lost during the fire in addition to the subsequent losses of carbon sequestration potential in the area impacted by wildfire. Prescribed fires may increase carbon in

soil, and mechanical removal of biomass may provide sources of biomass that can be used for conversion to energy. Note that over 90% of Kentucky's wildland fires are caused by humans, 50% of which are deliberately set.

6.7 Mitigation of Forest Loss Due to Insects and Disease

Programs that reduce insect damage to forests also reduce GHG emissions by maintaining the carbon sequestration achieved in healthy forests. Forests lost because of insects and disease provide space for exotic and invasive species, making reforestation difficult. Note that care should be given to protect stands whose treatment or replacement would be cost-prohibitive or very difficult (such as ash trees in urban areas, or hemlock stands killed by hemlock woolly adelgid).

6.8 Silvicultural and Technological Improvements

Adoption of water conservation, improved harvesting technology and equipment, and other GHG-reducing agricultural practices can be applied to silviculture. This policy encourages private landowners to adopt best practices. Note that costs associated with improved harvesting technology may be prohibitive to many loggers.

6.9 Wildlife Management to Encourage Vegetative Regeneration and Growth

Overpopulation of ungulates (e.g., deer and elk), porcupines, and other wildlife that consume or injure young tree and shrubs can have a significant impact on regeneration and riparian (streamside and wetland) vegetation. Measures to effectively control populations and avoid concentration of animals in sensitive locations can allow regeneration and growth of important species, thus increasing the above-ground biomass and its ability to sequester carbon.

New studies suggest that because of trophic cascade effects of reintroducing top predators (especially wolves and cougars), undergrowth and riparian vegetation are significantly improved in growth rate and coverage. Predators keep wild ungulates more wary and cause them to move more frequently, reducing the concentrated impacts of continual grazing. Wildlife numbers, particularly in ungulate populations, are somewhat reduced, which also decreases the impact of browsing on emerging vegetation. Overall biodiversity is significantly increased, improving the vegetative health and resiliency of wildlands.

6.10 Reforestation of Active Mining Operations and Previously Reclaimed Mined Lands

This option would promote mine reforestation practices that (1) plant high-value hardwood trees on reclaimed coal-mined lands, (2) increase the survival and growth rates of planted trees, and (3) expedite the establishment of forest habitat through natural succession.

The Forestry Reclamation Approach (FRA) focuses on foresting reclaimed coal-mined land under the Surface Mining Control and Reclamation Act (http://arri.osmre.gov/FRApproach.shtm). The Appalachian Regional Reforestation Initiative is a cooperative effort by the Appalachian states and the Office of Surface Mining to encourage restoration of high-quality forests on reclaimed coal

mines in the eastern United States and to promote the FRA. (See more details at http://arri.osmre.gov/ and http://arri.osmre.gov/Partnerships/green_forest_works/gfw.htm). Note that the Kentucky Department of Natural Resources has jurisdiction of reclaimed mined lands.

AFW-7. FORESTRY—WOOD PRODUCTS AND WASTE

7.1 Improved Mill Waste Recovery—Utilization of Sawmill Residues and Emissions

This option would improve treatment and cleaning of waste materials from paper mills, which can then be reused to manufacture additional wood products. It would ensure that sawmill by-products are recycled or beneficially used for energy, and promote opportunities for using mill CO_2 emissions to create chemical products, such as carbonates. Note that this option links to AFW-1.1 (Expanded Use of Biomass Feedstocks for Electricity, Heat, and Steam Production) and AFW-1.3 (Improved Energy Capture From Wood Waste and Biomass Combustion).

7.2 Improved Logging and Other Residue Recovery

This option would use more efficient logging methods to fully utilize harvested trees, which will minimize carbon losses from wood damaged during harvesting and maximize the potential for carbon sequestration in harvested wood products. It would process the logging remains, thereby efficiently minimizing waste; encourage investment in better equipment and the State Master Logger certification program; establish markets for insect-damaged and low-quality wood from managed areas; and discourage timber theft, which undermines forest management best practices.

7.3 Expanded Use of New, Reused, and Recycled Wood Products for Building Materials

This option would increase the amount of renewable wood products used for residential and commercial building. Using wood products in place of other building materials can increase carbon sequestration in wood products and displace GHG emissions associated with processing high-energy input materials, such as steel, plastic, and concrete. This option would also enhance reduction potential by promoting the use of locally grown wood because it has lower transport-associated emissions. It would promote utilization of recycled or reusable wood products to reduce wood waste, and encourage certification programs, such as Leadership in Energy and Environmental Design (LEED), to put wood on an equal footing with other materials. A key need during implementation of this policy is the establishment of an in-state marketplace, where producers and buyers can find one another.

7.4 Promotion of In-state Forestry Products

This option would promote the production and consumption of locally produced forestry goods, which displace the consumption of goods transported from other states or countries and reduce transportation-related GHG emissions. This option would also encourage products that come from certified forests and certified industries.

AFW-8. WASTE MANAGEMENT—WASTE MANAGEMENT STRATEGIES

8.1 Advanced MSW Reuse, Recycling, and Organic Waste Management Programs

This option would increase reuse, recycling, and composting programs in order to limit GHG emissions associated with landfill methane generation and with the production of raw materials. It would increase reuse and recycling programs for municipal solid waste (MSW), create new recycling programs, provide incentives for the reuse and recycling of construction materials, develop markets for reused and recycled materials, and increase average participation and recovery rates for all existing recycling programs. This option would also reduce the biodegradable fraction of waste emplaced through recycling of organic wastes (e.g., lawn and garden waste, food waste, wood, paper, and bio-based plastics); would encourage conversion technologies, including composting, anaerobic digestion, or hybrids of these technologies; and would include recycling of agriculture plastic waste (greenhouse plastic). Waste oils can serve as an energy feedstock. Reuse of waste materials leads to the highest GHG benefit by reducing the energy inputs associated with conversion of waste.

8.2 Expanded Use of MSW and Yard Waste Biomass Feedstocks for Electricity, Heat, and Steam Production

This option would increase the amount of biomass available for generating electricity and displacing the use of fossil energy sources. Local electricity or steam production yields the greatest net energy payoff. Note that this option is related to AFW-1.1, which uses biomass feedstocks for energy.

8.3 Promotion of Bioreactor Technology

A bioreactor landfill is essentially a landfill in which liquid, temperature, and air (for aerobic processes) are managed in a controlled manner to achieve rapid stabilization of the landfill's food, green waste, and paper-waste constituents. To optimize the rapid stabilization of these wastes, moisture, gas composition, gas flow, and temperature must be carefully maintained and monitored. Bioreactor technology is used to accelerate waste stabilization, enhance gas production and collection, control leaching, reduce volume, and minimize the long-term liability of waste. Note that leachate can be over-recycled, leading to problems with gas collection.

8.4 Source Reduction Strategies

This option would reduce the volume of waste from residential, commercial, and government sectors through programs that reduce the generation of waste. Reducing waste generation at the source reduces both landfill emissions and upstream production emissions.

8.5 Resource Management Contracting

Unlike traditional solid waste service contracts, resource management compensates waste contractors based on performance in achieving an organization's waste reduction goals, rather than

the volume of waste disposed of. As a result, resource management aligns waste contractor incentives with the goals to explore innovative approaches that foster cost-effective resource efficiency through prevention, recycling, and recovery.

8.6 Waste Coal Recapture

This option would maximize the efficiency of coal by utilizing waste coal.

8.7 Waste Management Feedstocks for Liquid/Gaseous Fuels Production for Stationary and Mobile Applications

This option would use MSW biomass (waste wood, landscape debris, other fiber) to produce liquid or gaseous biofuels for use in transportation or stationary energy needs. For example, this biomass could include cellulosic ethanol feedstocks, biomass gasification feedstocks, etc.

8.8 Industrial Waste Management Programs

This option would promote programs in the industrial sector to reduce, reuse, and recycle waste and would promote source reduction and organics management in the industrial sector. The recent organics management in the bourbon industry is an example.

8.9 Utilization of Closed Landfills for Other Purposes

This option would use the surface of closed landfills for development of greenfields or other purposes. Note that this option may have crossover with the land use sector (covered in the Transportation and Land Use Technical Work Group).

AFW-9. WASTE MANAGEMENT—LANDFILL GAS STRATEGIES

9.1 Flare Landfill Methane at Non-NSPS (Smaller) Sites

This option would encourage smaller landfills that do not fall under environmental protection regulations to capture and flare methane gas. Flares are used to safely combust toxic and volatile gases from landfills and to convert methane gas, which has a relatively high global warming potential, to CO_2.

9.2 Methane and Biogas Energy Programs

This option would encourage and promote the use of anaerobic digesters and energy recapture for waste materials other than MSW at landfills (e.g., food processing waste). These projects will help prevent the emission of methane while producing clean energy. Anaerobic digesters make a two-fold contribution to climate protection: the usual unchecked discharge of methane into the atmosphere is prevented, and the burning of fossil fuels is replaced with renewable energy (biogas).

9.3 Landfill Methane Energy Programs

This option would use the renewable energy created at landfills by anaerobic digesters (methane) to make electric power, space heat, or liquefied natural gas. Some of these applications are already under development in the state; however, regulatory and legal barriers have limited the penetration of this option.

AFW-10. WASTE MANAGEMENT—WASTEWATER MANAGEMENT ACTIVITIES

10.1 Energy Efficiency/Technology Improvements

This option would provide incentives for efficiency improvements or technology upgrades; encourage the setup of energy policies, energy audits, and energy cost tracking; and identify and implement energy improvements, such as using energy-efficient equipment and generating on-site power (e.g., solar power, digester gas).

Common energy efficiency improvements cover lighting, pumps, and fans. Other improvements can include:

- Conversion of secondary aeration processes to fine-bubble diffusion and optimization of oxygen transfer efficiencies.
- Research and development (R&D) of diffuser cleaning protocols.
- R&D to increase removal of chemical oxygen demand in primary treatment tanks and clarifiers.
- Evaluation of steam usage in plant processes and biofilters, optimization of use, and promotion of alternatives. .
- R&D of options to optimize denitrification in secondary treatment;
- R&D of ways to use wastewater biomass as an energy source, rather than a soil carbon source.

Financial and performance analyses that may be conducted to assist the implementation of this option include:

- Creation of a leveraged state revolving loan fund program to capitalize energy efficiency in municipal wastewater treatment plants (WWTPs).
- Conducting benchmarking of energy use per million gallons treated in state to showcase good and deficient energy performance in this specific climate.

10.2 Lower Wastewater Processing Needs

This option would develop and implement best practices for lowering water consumption and waste production in the industrial, commercial, and residential sectors. It would encourage and create incentives for R&D on methods or technologies to reduce water consumption and waste production, provide education to reduce water consumption and waste production, and promote the use of

"reclaimed" water from WWTPs for the purpose of irrigating urban green space. Lower water consumption and production lead to lower GHG emissions.

10.3 Install Digesters and Turbines or Engines

This option would provide incentives to install anaerobic digesters to treat municipal waste and create methane, and would install turbines or reciprocating engines to generate electricity from the methane. Reductions occur via methane control and offsetting fossil energy use. This option would also provide incentives to recover heat from wastewater influent or effluent through the use of heat pumps, and would investigate opportunities for waste heat recovery from biogas combustion units (turbines, engines, flares).

10.4 Wastewater Treatment Plant Biosolids for Energy Production

This option would develop and implement methods for biosolids processing and use as a renewable energy source—for example, as a renewable fuel to be co-fired with other fuels in existing or new combustion units for the purpose of generating electricity, heat, or steam.

10.5 Algae in Effluent and Bio-Oils as an Energy Source

This option would provide financial incentive to research the production of bio-oils from algae or other microorganisms grown in wastewater effluents (which would reduce carbon, nitrogen, and phosphorus).

10.6 Utilization of Biosolids as a Fertilizer Substitute

This option would promote the use of residual biosolids from wastewater treatment plants on farms in order to replace fossil-derived fertilizers.

10.7 Utilization of Stormwater Runoff for Green Space Irrigation

This option would promote the use of rain runoff from streets, parking lots, and other paved areas for the purpose of irrigating green space in urbanized areas. Offsetting the use of water treated for domestic use offsets the GHG emissions associated with the energy consumed to treat domestic water.