APPENDIX 1:
CALCULATING GHG EMISSIONS FROM PROPOSED PROJECTS RELATED TO ECOLOGICAL FUNCTIONS

January 2026

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Introduction

Purpose and Scope

In 2024, the Montana Supreme Court issued its opinion in *Held v. State of Montana*, finding that the Montana Environmental Policy Act (MEPA) prohibition to agencies considering greenhouse gas (GHG) emission impacts in their environmental reviews, as promulgated in § 75-1-201(2)(a), Montana Code Annotated (MCA), violated the Right to a Clean and Healthful Environment found in Montana's Constitution.[1] In the 2025 session, the Montana Legislature passed Senate Bill 221 (SB 221) and House Bill 270 (HB 270) to address the *Held v. State of Montana* opinion and directed the Montana Department of Environmental Quality (DEQ) to develop a guidance document and supporting technical memoranda (memos) advising state agencies on how to evaluate GHG emissions[2] pursuant to MEPA. SB 221 (§ 75-1-201(2), MCA) specifically directs DEQ to address the following issues: (1) *when* a GHG assessment under MEPA may be necessary and (2) *methodologies* for completing a GHG assessment.

The purpose of this appendix to the *Guidance for Greenhouse Gas Impact Assessments under the Montana Environmental Policy Act* (Guidance Document) is to review methodologies and strategies that can be used to assess GHG emissions, specifically those related to state land management activities that involve maintenance or promotion of ecological functions. Ecological functions are the natural interactions and processes that maintain a healthy ecosystem and its ability to provide benefits to humans and other organisms. One important ecological function performed by forests and grassland ecosystems in Montana is the regulation of the carbon cycle, contributing to the long-term GHG balance in the atmosphere. GHG balance refers to the net difference between the GHGs emitted into the atmosphere and the GHGs removed or absorbed within an ecosystem over a defined period. GHG fluxes reflect the rate of transfer of GHGs between different components of the Earth system or *pools*, such as the atmosphere or the land. Land management activities (described below) may impact ecological functions and, particularly, the carbon cycle, either by facilitating carbon sequestration (e.g., carbon storage or sink) or by disturbance (e.g., vegetation management), which, in some cases, may initially increase GHG emissions but ultimately may balance the carbon cycle over the long term. This appendix will help MEPA practitioners determine the appropriate methodologies, models, and best practices to use for calculating GHG emissions associated with projects that involve maintenance or promotion of ecological functions.

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[1] See *Held v. State of Montana*, 2024 MT 312.

[2] According to the Montana SB 221, "Greenhouse gas emissions" means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Management Activities with GHG Implications

In Montana, land management activities are implemented by state agencies (primarily the Montana Department of Natural Resources and Conservation [MDNRC] and Montana Fish, Wildlife, and Parks) in forested ecosystems and grasslands with the dual goal of improving ecosystem health and supporting state land use objectives (MDNRC 2020, 2024). Land management activities can be either active or passive. Active land management activities including timber sales, controlled or prescribed burns, forest thinning, noxious weed management, and grazing management may initially release carbon dioxide and other GHGs due to vegetation removal, combustion, or soil disturbance in the ecosystem. However, these actions often enhance long-term ecological function and ecosystem resilience, such as reducing wildfire risk, promoting native vegetation recovery and regrowth, improving forage quality, and increasing carbon uptake in regrowing biomass and soils. For example, prescribed burns may emit carbon initially, but would eventually stimulate regrowth of fire-adapted species and increase belowground carbon storage. In grasslands, deep-rooted native grasses can store large amounts of carbon in the soil, while in forests, healthy tree regeneration and understory development contribute to aboveground and belowground carbon storage. These offsetting ecological functions play a crucial role in restoring ecosystem health and can partially or fully mitigate the GHG emissions associated with the initial disturbance, making them important to consider in environmental evaluations under MEPA.

In addition to active management, passive land management activities including conservation easements, which may be on private lands, and habitat restoration activities, play a role in long-term carbon sequestration. These activities may include replanting native species, wetland enhancement, erosion control, and soil rehabilitation. These activities typically involve fewer immediate emissions but contribute to enhanced ecosystem services over time, including improved carbon storage, water regulation, and biodiversity support. Understanding how each of these practices contributes to both GHG emissions and their potential offsets through ecological processes is critical for MEPA practitioners tasked with evaluating the net climate impact of proposed actions on public lands (e.g., a wildlife management area or state forest) or that are authorized or funded by state agencies but occur on private lands (e.g., a wetland constructed by a private entity to manage storm water runoff that is placed under a conservation easement).

Selection Criteria and Assumptions

Criteria

To select the most relevant models or tools for calculating GHG emissions in the context of land management activities, a literature review was completed. The following criteria were applied and used during the literature review:

1- ***Accessibility***: The model or tool must be open source, free, or easily accessible by state MEPA practitioners.
2- ***Applicability***: The models or tools must be applicable to forested stands or ecosystems, grazing landscapes, or otherwise rural vegetated environments.
3- ***Scale***: The scale of analysis must be state-level emissions or smaller (parcel-level, project level, etc.)
4- ***Data Input Requirements***:
    a. ***Limited Data***: It was assumed that MEPA practitioners would have limited access to project-specific field data; therefore, for a model or tool to be useful for a MEPA analysis, it must require moderate to low data inputs.
    b. ***GHG Emissions:*** Most models and studies primarily focus on CO_2 emissions; therefore, DEQ recommends the use of CO_2 equivalent (CO_2e)[3] for other gases such as methane (CH_4) and nitrous oxide (N_2O), unless otherwise noted in the model summaries.

Models or tools that did not adhere to the above criteria were not analyzed further and are not described in this appendix.

Assumptions

The following assumptions were considered when evaluating potential models or tools and should be kept in mind by MEPA practitioners:

1- ***Ecological functions occur over a long-term temporal scale:*** GHG assessments under MEPA may consider not only the immediate emissions from land management actions but also their long-term ecological outcomes. Short-term analyses may overstate the climate impact of activities like prescribed burns or thinning, which are designed to promote long-term vegetation recovery and carbon sequestration. Selecting an appropriate temporal scale is essential to accurately capture the full climate trajectory of proposed actions, particularly in ecosystems where recovery and offset processes operate over decades. A qualitative assessment may be used when locations and timing

[3] CO_2e is used to express the total impact of multiple GHGs in a single number by converting them into the equivalent amount of CO_2 based on how strongly they heat the atmosphere (their global warming potentials).

of emission sources and sinks are not specifically defined (e.g., forest management where wildfires may occur but where regenerative growth is encouraged).

2- ***Ecosystem resilience is not guaranteed:*** An important limitation in many existing GHG models is the assumption that ecosystems will recover predictably following management interventions. However, ecosystems face increasing risks of crossing ecological thresholds due to climate change, invasive species, and repeated disturbances. Once these thresholds are crossed, recovery may stall or reverse, reducing or eliminating the expected carbon offsets. While the models presented in this appendix do not incorporate resilience indicators or probable approaches to account for the potential of ecosystem regime shifts, particularly in areas already under ecological stress, practitioners should keep in mind the variable nature of the Earth's ecosystems and associated uncertainties.

Data Availability Considerations

The level of analysis indicated for each model or tool profiled in this appendix is based on the Intergovernmental Panel on Climate Change (IPCC)'s three tiers, which correspond to levels of methodological complexity and are described below (IPCC 2006). For a more detailed description of methodological tier levels and associated advantages and tradeoffs, see U.S. Environmental Protection Agency (EPA) 2024 or Institute for Global Environmental Strategies 2025.

Tier 1: This is the simplest approach to implement, where basic activity data (such as treated acreage) is combined with the IPCC's default emission factors, giving a quick estimate but also the greatest uncertainty. Simpler, easier approaches may be valuable when time or resources are limited but GHG estimates are required.

Tier 2: This intermediate approach replaces global defaults with state- or region-specific factors and breaks activities into finer categories. Therefore, it requires some local data but yields more accurate results than Tier 1. This level offers a more accurate option when more time or resources are available but advanced data are not readily available.

Tier 3: This most advanced approach uses process-based models or direct, repeated field measurements to track emissions and removals year by year at the site level, demanding the most data and expertise but providing the highest precision.

Evaluation of GHG Modeling Approaches

Selected Models and Tools

The literature review identified more than 20 models or tools with the potential to be used for GHG accounting. Each model or tool was evaluated and weighed against the selection criteria and assumptions described above. Six models or tools were identified as applicable and meeting the identified criteria and assumptions. Table 1 provides a summary of the six models or tools retained for discussion and is followed by detailed discussions of each in the subsequent sections.

Table 1. Summary of selected GHG accounting models and tools.

Model Name	Ecosystem Type	Land Management Activity	Temporal Scope	Carbon Pools Modeled	Units	User Interface	Tier Level*	Notes	Reference
Active Land Management									
BlueSky Framework	Forest	Prescribed/ controlled burns	Variable	Default is total fuels; advanced options to narrow down fuels	Tons per acre	Web based	1/2/3	Includes several GHGs, defaults available	Larkin et al. 2009
CBM-CFS3	Forest	Timber sales; prescribed burns; forest thinning; conservation easements; restoration	Annual and up to 100 years	All IPCC forest pools (live, dead, soil	Tons of carbon per year (convertible to CO_2e)	Software	3	Minimal inputs (fuel model, moisture, and weather); good for farm-scale units	Kurz et al. 2009 California Air Resources Board for 2021 wildfire emission inventory
Fuel and Fire Tools (FFT): Fire emission Production Simulator (FEPS)	Forest and grasslands	Prescribed/ controlled burns	Hourly	Total fuels	Tons (CO_2 or CO_2 equivalent)	Software	2/3	Also calculates N_2O and CH_4 as CO_2 equivalent; COMET-Farm available for more in-depth assessment; based on Natural Resources Conservation Service (NRCS) Conservation Practice Standard (CPS)	Swan et al. 2020
Land Use, Land Use Change, and Forestry (LULUCF) Module	Forest and grasslands	Any forest activities that lead to carbon flux (prescribed/ controlled burns, forest thinning, etc.) Grassland management	Annual	Aboveground/belowground biomass, deadwood, litter, soil organic carbon, and total agricultural soil carbon flux (applicable to grasslands)	T CO_2e	Excel module	1/2	Calculates CO_2, CH_4, and N_2O	Prichard 2018
Passive Land Management									
COMET-Planner	Forest and Grassland	Forest restoration; grazing management	Annual	Total CO_2	Tons of CO_2 equivalent per year	Web-based	2	See COMET-Farm for more advanced features	Swan et al. 2020
Forest Landscape Restoration (FLR) Carbon Storage Calculator	Forest	Forest restoration	Up to 20 years	Total estimated carbon stored	Tons of CO_2	Web-based or Excel module	1		Bernal et al. 2018; Windrock International 2025

**Typical tier if run with built-in defaults; tiers can be adjusted if given additional data.*

Active Land Management

BlueSky Framework

Best for: prescribed and controlled burns

Website:https://tools.airfire.org/playground/v3.5/emissionsinputs.php

Overview: BlueSky Framework is a web-based modular framework that links fire and site-specific information to produce emissions estimates for prescribed and wildland burns. It was created by the U.S. Department of Agriculture (USDA) Forest Service (USFS) Pacific Northwest Research Station AirFire Research Team (Larkin et al 2009). The development and continued support of the BlueSky Playground tool involves collaboration among several federal agencies and institutions, including the EPA, National Oceanic and Atmospheric Administration, National Weather Service, University of Washington, Washington State Department of Ecology, and Interagency Wildland Fire Air Quality Response Program, as well as state and local air quality agencies. These partners contribute expertise in fire behavior, meteorology, emissions, air quality modeling, and public health. BlueSky is publicly accessible at no cost. BlueSky relies on multiple models or modules (ensemble modeling) to estimate smoke dispersion and GHG emissions among other outputs, including the Fuel Consumption and Emissions Calculator (CONSUME) and the First Order Fire Effects Model (FOFEM) (Urbanski et al. 2022; Lutes 2020; Prichard et al. 2014). CONSUME predicts how much fuel is consumed during a fire and estimates emissions and FOFEM uses similar data to predict fire effects such as tree mortality, soil heating, and smoke production.

MEPA applications: The best use of this framework in the context of MEPA is for prescribed or controlled burns in forested landscapes where activity-based emissions are needed for integration into broader impact analyses. BlueSky provides an estimate of the initial emissions fluxes with moderate input needs when defaults are used. The tool computes emissions from fire events but does not include vegetation regrowth or carbon-stock calculations. If net GHG emissions over time is required, BlueSky could be paired with a separate regrowth or restoration method, such as the FLR Carbon Storage Calculator (see below; Winrock International 2025). Spatial scale typically ranges from project site to regional estimates. Statewide aggregation for MEPA screening would require a consistent activity dataset and calculations not provided in the tool itself.

The tool estimates the immediate emission fluxes associated with fire activity reported in tons per acre. By adjusting inputs and methods, the model can implement IPCC Tier 1, Tier 2, or Tier 3 approaches, but most naturally aligns with Tier 2 or Tier 3. Therefore, the tool is best suited for practitioners with moderate to advanced experience with data analysis, and moderate data availability.

Total emissions are reported in the BlueSky Framework in tons for the following criteria air pollutants and GHGs: particulate matter $(PM)_{2.5}$, $PM_{10,}$ carbon monoxide (CO), CO_2, CH_4, nitrogen oxides (NO_x), volatile organic compounds (VOC), ammonia (NH_3), and sulfur dioxide (SO_2), as well as total GHGs. Minimum required data inputs are location, fire size (acres) and fire type (prescribed versus wildfire), with the option to override defaults by using the advanced emissions input feature. Standard fire and site-specific input information includes fuel type (vegetation community type), fuel moisture level, consumption percentage for shrub, pile, and canopy, and fire timing. Advanced settings allow users to input more precise fuel information (such as sound or rotten wood, piles, etc.), advanced moisture parameters, shrub and canopy consumption different from default, and to select detailed combustion phase parameters.

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

Best for: all forest management practices

Website: https://natural-resources.canada.ca/climate-change/climate-change-impacts-forests/carbon-budget-model

Overview: The CBM-CFS3 is a comprehensive forest carbon accounting framework used to simulate the impact of forest management scenarios on carbon sequestration and emissions (Kurz et al. 2009). It was developed by the Canadian Forest Service, Northern Forestry Centre over the past few decades in collaboration with several Canadian federal and provincial government entities, academic institutions, and other international researchers. The model allows users to create baseline and alternative scenarios to compare impacts on carbon dynamics at both stand and landscape scales. CBM-CFS3 can be used to simulate carbon stocks and emissions for living biomass, dead organic matter, and mineral soil carbon pools, and to compare land management activities including timber harvesting, thinning, fire suppression, and regrowth changes. It has been used extensively by the international research community for carbon budget modeling (see examples listed in Natural Resources Canada 2025).

MEPA applications: Although CBM-CFS3 was designed for Canadian forests, it is adaptable to other forest types such as Montana's forests if adequate data (inventory, yield curves, disturbance regimes, and ecological parameters) are available. Because CBM-CFS3 records each disturbance and then projects post-disturbance carbon uptake, it would allow MEPA practitioners to show how an action that produces an immediate emissions pulse (e.g., prescribed burning or forest thinning) is offset by sequestration as the stand recovers or is managed differently. The model outputs annual and cumulative carbon totals for all major GHG pools, enabling comparison of baseline and action scenarios over any analysis horizon. This makes it possible to demonstrate the net carbon sequestration potential of a project while explicitly accounting for ecological functions that may offset initial GHG emissions, satisfying the objective to present total long-term emissions rather than just the initial GHG pulse. CBM-CFS3 provides estimates for all three major GHGs associated with forest carbon cycling including CO_2, CH_4, and N_2O.

Extensive inputs and careful data preparation are required, but the resulting Tier 3-level simulation provides a rigorous evaluation of GHG emissions associated with forest-management practices under MEPA. Data required includes forest inventories, species-specific yield curves, disturbance regimes (natural disturbances such as fire and insects, and management actions), and precise formatting for import. Proficiency in data preparation and interpretation of model outputs is essential. Self-guided training tutorials and supporting documentation are available. The model is compliant with the 2003 IPCC Good Practice Guidance For Land Use, Land-Use Change and Forestry, and the 2006 IPCC Guidelines for National GHG Inventories IPCC (IPCC 2003, 2006) and supports Kyoto Protocol accounting.

FFT: FEPS

Best for: prescribed and controlled burns

Website: (FFT) https://depts.washington.edu/fft/ and https://www.frames.gov/catalog/17633 (FEPS) https://research.fs.usda.gov/pnw/projects/feps and https://www.frames.gov/catalog/7173

Overview: FEPS is distributed as one of the calculators in the USFS FFT desktop suite (Prichard 2018). It is publicly available at no cost, runs offline once installed, and is maintained by the Fire and Environmental Research Applications team. The package includes linked modules that would typically be used with FEPS to allow fuelbed type (i.e. types, quantities and arrangement of fuels) and fuel consumption and parameter selection within one workflow: the CONSUME module (described above under BlueSky Framework) and the Fuel Characteristic Classification System (FCCS), which describes fuel types and quantities across different vegetation types. This calculator has been integrated into the BlueSky Framework but also functions as its own tool through the software application. Alternatively, outputs from the FEPS can be integrated into the BlueSky Framework.

MEPA applications: FEPS could be used in the MEPA process to quantify GHG emissions for proposed prescribed or controlled burns at the project scale. Fuel-load and environmental data inputs from FFT (e.g., selected FCCS fuelbeds, fuel moistures, and hourly weather) could be used to estimate fuel consumption, heat release, plume-rise parameters, and pollutant emissions for prescribed burns and wildfires in forest, shrub, and grassland fuels. GHGs and criteria air pollutant reported by this tool include CO_2, CO, CH_4, and $PM_{2.5}$. If CO_2e is required, FEPS-reported CO_2 and CH_4 can be combined using the selected 100-year global warming potentials to estimate N_2O externally. A published biomass-burning N_2O emission factor (e.g., from the USFS's Smoke Emissions Reference Application, SERA) to FEPS dry-fuel consumption can be used before converting to CO_2e (IPCC 2006). Results from this model could then be paired with a separate regrowth or restoration method such as the FLR Carbon Storage Calculator (see description below) to represent post-fire recovery GHG trajectory.

Results are sensitive to fuelbed selection, fuel moisture, meteorology, and the emission-factor path chosen. Default factors may not reflect local conditions if site-specific data are limited but provide an easier entry point for practitioners lacking extensive data or data preparation experience. The tool does not provide built-in regional aggregation; therefore, any statewide or regional summary requires manual aggregation of individual runs. With default fuelbeds and emission factors, it aligns conceptually with an IPCC Tier 2 approach. With site-specific fuels, moistures, and meteorology, it functions as a Tier 3 event simulation (this tier mapping is an interpretation, not an official designation). This tool would be suitable for a range of data availability and experience levels. However, we recommend using the BlueSky Framework (described above) for users with limited data and experience desiring a Tier 1 approach for prescribed and controlled burns GHG emissions calculations.

LULUCF Module

Best for: Forest activities that lead to carbon flux (prescribed/controlled burns, forest thinning, etc.) and grassland management

Website: https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool.

Overview: The LULUCF module is one of ten State Inventory Tools (SITs) that were developed in conjunction with EPA's Emissions Inventory Improvement Program (EIIP). The LULUCF module is a macro-enabled Excel workbook that compiles annual GHG emissions and removals from land use, land use change, and forestry using methods consistent with the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (ICF 2024). The module is publicly available as part of EPA's SIT download package.

MEPA applications: For MEPA analyses, the best use of the LULUCF module is any forest or grassland activity that leads to carbon flux where annual GHG emissions accounting is needed and data inputs can be kept moderate by relying on defaults or increased where state-specific data justify refinement (ICF 2024). The LULUCF module is broken down into 6 sections representing different sinks and sources of GHG emissions: forest carbon flux, urban trees, N_2O from settlement soils, non-CO_2 emissions from forest fires, carbon storage in landfilled yard trimmings and food scraps, and agricultural soil carbon flux. Grassland management activities are covered under the agricultural soil carbon flux section.

The LULUCF module calculates annual CO_2, CH_4, and N_2O emissions. The module covers the main carbon pools, including aboveground and belowground biomass, dead wood, litter, and soil organic carbon, as well as related categories such as harvested wood products, settlement soils, and non-CO_2 emissions from forest fires, with results summarized in MMT CO_2e per year (ICF 2024). Users can apply provided defaults or substitute state-specific inputs where available (ICF 2024). The module is a complex multistep process, but a detailed user guide has been developed to walk users through data input needs and worksheet procedures for each of the six sections (ICF 2024). The module requires Tier 1 level data inputs when relying on the module's default factors and activity data and Tier 2 when substituting documented state-specific activity and flux data by pool. However, this module may require a greater experience level because users must have familiarity with the use of Excel workbooks and follow multiple steps to obtain estimates.

Passive Land Management

COMET-Planner

Best for: grazing management, forest restoration, and conservation easement

Website: https://comet-planner-cdfahsp.com/

Overview: COMET-Planner is a web-based GHG evaluation tool developed by Colorado State University in partnership with the USDA Natural Resources Conservation Service (NRCS; Swan et al. 2020). It is intended for initial conservation planning across the contiguous United States and is built around NRCS Conservation Practice Standards (CPS), making it most applicable to agricultural land management decisions or land conversion from agriculture to silvicultural or forested systems. NRCS CPS include the following: cropland management, grazing lands, cropland to herbaceous cover, restoration of disturbed lands, and woody planting. While COMET-Planner is based on NRCS conservation practices, many of the practices adopted under Montana's state-level programs closely align in structure and intent with the NRCS standards (such as cover crops [340], conservation crop rotation [328], range planting [550], and prescribed grazing [528]), ensuring broad applicability and consistency.

MEPA applications: In the context of MEPA, COMET-Planner would be helpful to estimate GHG fluxes associated with land management activities that are likely to increase the density of vegetative growth on the land. COMET-Planner can serve as a screening tool to estimate the direction and approximate magnitude of net GHG effects from adopting NRCS CPS in forest-related restoration and grazing management. The adoption of a conservation practice is compared to a baseline for the generation of a GHG estimate. For example, the tool can estimate GHG fluxes from the adoption of prescribed grazing (CPS 528) that would implement grazing management to improve rangeland or nonirrigated pasture conditions.

Approximate carbon sequestration and GHG emission reduction estimates are provided in COMET-Planner in tons of CO_2e per year for CO_2, CH_4, N_2O, and total CO_2e. Results are typically generated over a 10-year period and presented as an annual average. The annual CO_2e outputs at county to multicounty scale allow users to show whether a proposed action that may include an initial emissions pulse is expected to be offset by practice-driven ecological uptake when averaged over the planning horizon. COMET-Planner generalizes region-specific parameters and does not simulate project-level GHG fluxes trajectories. When MEPA analysis requires a project-scale total that traces sequestration through time, COMET-Planner should be used as the planning-level screen and paired with a higher-resolution method such as COMET-Farm or a stand-level carbon model to quantify the GHG balance or trajectory. This use meets MEPA's needs for accessibility and applicability while keeping inputs moderate, and it is best suited to land management activities implemented through NRCS woody or restoration standards and to grazing management actions.

Data input needs are moderate to low because users select the appropriate CPS and area in acres directly within the web interface rather than compiling stand-level inventories or running process models. No other data input is required, which makes this method accessible to all experience levels. COMET-Farm, a related tool, handles detailed site-specific accounting at a Tier 3 modeling level. However, for the purpose of MEPA GHG accounting, COMET-Planner provides an easier entry point with a Tier 2 approach that uses region-specific coefficients tied to NRCS-listed practices. The tool's streamlined interface makes it especially valuable for users with limited technical expertise, providing an accessible science-based starting point for estimating conservation benefits and GHG emissions. This balance of simplicity and credibility helps reduce barriers to participation while maintaining alignment with both state and federal conservation frameworks.

FLR Carbon Storage Calculator

Best for: forest restoration and conservation easement

Website: https://winrock.org/flr-calculator/

Overview: The FLR Carbon Storage Calculator is a public web-based tool developed by Winrock International to estimate carbon removed by forest landscape restoration activities using literature-derived accumulation rates synthesized by Bernal et al. (2018). Access is via a public web interface hosted by Winrock International or via a downloadable Microsoft Excel tool.

MEPA applications: The calculator covers three activity types applicable to Montana's ecosystems, including natural regeneration, planted forests and woodlots, and agroforestry. Data inputs required include annual areas restored per year and up to 20 years, and outputs are annual and cumulative CO_2 sequestered for that period (Winrock International 2025).

Users select geography (country and state), select species if calculations are for plantations and woodlots, and enter annual hectares restored for up to 20 years. Species options to select from are limited to eucalyptus, other broadleaf, oak, pine, and other conifer. Therefore, this method may not be suitable if a greater level of specificity is needed or if the species are not specific to the area being evaluated. The output provided by the tool includes annual and cumulative results in metric tons of CO_2 over a 20-year horizon (Bernal et al. 2018; Winrock International 2025). The rate of carbon sequestration represents biomass (aboveground and belowground) converted to CO_2. Soils, litter, and dead wood are not included in these estimates (Bernal et al. 2018).

Data inputs are intentionally low because the method applies published activity and region-specific accumulation factors rather than site-specific growth modeling. Conceptually, this aligns with an IPCC Tier 1 style approach and, therefore, is suitable for all experience levels and for practitioners with no detailed site data (Bernal et al. 2018). For MEPA applications, the calculator is suitable to screen carbon sequestration expected from forest restoration actions and to present those removals alongside separate estimates of any initial emissions pulse from the proposed action so that the net effect over time can be communicated. Because the calculator estimates restoration-driven CO_2 storage only and does not simulate emissions or project-specific dynamics from activities outside of tree growth, these results should be paired with a higher-resolution growth model for more complex projects (Bernal et al. 2018). For example, the tool does not simulate detailed carbon fluxes over time such as tree mortality, harvesting, natural disturbances (like fire or pests), and site-specific growth patterns. The calculator is best for forest restoration screening where a low-input estimate of CO_2 sequestration is needed that can be combined with an emissions estimate to meet MEPA's objectives. Limitations include reliance on generalized (non-site-specific) rates, the fixed 20-year window, and the absence of built-in multigeography aggregation. Any state-level estimate must be calculated by exporting and summing results from multiple runs (Winrock International 2025).

Summary

The model or tool used will depend on the type of land management activity and the available data. MEPA practitioners can determine the appropriate model or tool to use by first identifying the type of projects for which emissions need to be calculated and determining the level of data and resource availability for their project. The methods presented in this appendix offer a range of options for both active and passive land management projects. Passive land management projects tend to take place over longer timeframes and require more flexibility, which may translate into the use of Tier 1 methodologies that allow for estimation based on defaults. Conversely, active management projects, such as prescribed or controlled burns and forest thinning, could benefit from the use of more complex models or tools that use Tier 2 or Tier 3 methodologies. The CBM-CFS3 model stands out as allowing for a full GHG inventory using a long-term sequestration scenario at a Tier 3 level but requires a high degree of skill and expertise.

The models described in this appendix do not encompass all available models, tools, or studies. We have selected models that most closely align with the objective of calculating GHG emissions for land management activities in Montana for MEPA purposes. Additionally, software or web-based tools are regularly updated and improved. This appendix represents a starting point for practitioners; we recommend carefully researching each model before use and paying attention to model or tool version updates.

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