Project name Project Carbon Effects

National Forest name National Forest, Region Name Region

Prepared By: Name, Title

For: District Name, EMA

Date: Month Day, Year

1.0 Overview

1.1 Introduction and Consistency with Relevant Laws, Regulations, and Policy

On January 9th, 2023, the Council on Environmental Quality (CEQ, 2023) published the *National Environmental Policy Act (NEPA) Guidance on Consideration of Greenhouse Gas (GHG) Emissions and Climate Change*. The CEQ guidance applies to Environmental Assessments (EA) and Environmental Impact Statements (EIS) scoped January 10, 2023 or later. It provides numerous recommendations to agencies, including that agencies: 1) consider the projected GHG emissions or reductions for proposed actions and their reasonable alternatives (Section IV); 2) use this information to assess potential climate change effects (Section V); 3) assess the potential future state of the affected environment in NEPA analyses (Section VI); and 4) consider the impacts of climate change on project actions and alternatives. For more information on incorporating climate change into NEPA Environmental Analysis, see Brandt and Schultz (2006).

The CEQ guidance recommends the use of the high-quality, science-based, and accessible information and tools to guide these analyses. However, the guidance advises agencies to follow a rule of reason and the concept of proportionality in determining the appropriate depth of analysis. This guidance includes a recognition of the inherent complexities and uncertainties associated with analyzing projected biogenic carbon stocks and related fluxes for land and resource management actions under uncertain future climate conditions. To guide national forests and grasslands in interpreting the CEQ guidance, on December 13th, 2023, the US Forest Service (USFS) released *Forest Service Guidance for Project-Level Consideration on Climate Change and Greenhouse Gas.*

This project-scale NEPA carbon effects analysis focuses solely on biogenic carbon, hereafter ‘carbon.’ It incorporates qualitative and quantitative information on carbon stocks, fluxes, and drivers from the National Forest name Forest unit-level Carbon White Paper ([insert Carbon White Paper citation]) and, when available, other resources, including peer-reviewed scientific literature, technical reports, and emissions quantification tools and frameworks. The Carbon White Paper uses Forest Inventory and Analysis (FIA) Program data to provide a nationally consistent assessment of baseline forest carbon stocks at the National Forest scale. The Carbon White Paper also provides a national forest-scale evaluation of the influences of disturbances and management activities from 1990-2011, using the Forest Carbon Management Framework (ForCaMF), and estimates of the long-term relative effects of disturbance and non-disturbance factors on carbon stock change and accumulation, using the Integrated Terrestrial Ecosystem Carbon (InTEC) model ([insert Carbon White Paper citation]).

1.2 Carbon Dynamics in Forest Ecosystems

{Optional section; brief review of carbon dynamics. You may delete if you would like to solely rely on references to the Carbon White Paper.}

Terrestrial ecosystems play an important role in the global carbon cycle. Through photosynthesis, plants sequester carbon dioxide from the atmosphere and store some of the carbon as biomass. Forest carbon stocks are highly dynamic, with carbon frequently transferring among pools such as from living to dead biomass and dead biomass to the soil or the atmosphere. The balance of carbon sequestration versus atmospheric emissions determines the size of the total forest carbon pool, which fluctuates over longer periods of time. Frequency of stand-replacing disturbance has a large effect on ecosystem carbon stocks and sequestration rates, with the most rapid uptake of carbon often occurring in young forest stands.

Carbon is also stored in harvested wood products (HWP) outside of the forest ecosystem. The percentage of harvested carbon stored as HWP varies regionally, depending on mill efficiencies, dominant types of HWP, and HWP markets. HWP carbon storage declines over time, as products reach their end-life. Some carbon continues to be stored in solid waste disposal sites (or landfills), where decomposition rates are generally slow. When wood fiber is used in place of materials that are more energy-intensive to produce, such as concrete and steel, this generates a substitution effect which can result in lower overall greenhouse gas emissions. Substitution potential does not include the CO_2eq stored in HWPs; rather, it only characterizes the reduced fossil fuel emissions associated with energy or product production.

The influence of forest management on atmospheric carbon exchange has gained attention in recent decades due to its potential to influence the exchange of carbon with the atmosphere, either by accumulating and storing carbon or releasing carbon emissions (i.e., carbon dioxide or CO_2). This exchange has implications for climate change as carbon dioxide is a greenhouse gas that regulates our climate. Climate change is a global phenomenon, because major greenhouse gases mix well throughout the planet's lower atmosphere. At present, within the United States, forested lands are a carbon sink, taking in (sequestering) and storing more carbon than they are emitting into the atmosphere (Domke et al., 2023). Forests, including woodlands, urban trees, and harvested wood products, are the largest terrestrial sink in the United States, offsetting more than 12.4 percent of total U.S. GHG emissions (Domke et al., 2023). In 2021 alone, forest land, HWP, woodlands, and urban trees in settlements collectively stored 785.0 teragrams (Tg; 1 Tg is equivalent to 1 million metric tonnes) of carbon dioxide equivalent (785.0 Tg of CO_2e), bringing the total US forest and harvested wood carbon stock to 59,511 Tg CO_2e. The "forest land remaining forest land" category (i.e., maintaining forest (or forested) land) was the largest net sink in the land sector, with an estimated annual uptake of 592.5 Tg CO_2e in 2021 (Domke et al., 2023; EPA, 2023).

A complete assessment of forest carbon stocks and the factors that influence carbon trends (management activities, disturbances, and environmental factors), as well as underlying data and methodologies, for the National Forest name NF is available in the project record in the Carbon White Paper ([insert Carbon White Paper citation]). The Carbon White Paper only includes a quantitative analysis of forest carbon (the majority of which is derived from FIA data) and does not include quantitative analysis of non-forested lands. This carbon effects analysis contains additional supporting information and references.

1.3 Carbon Dynamics in Non-Forested Ecosystems

{Optional section; delete if project: a) excludes non-forested areas or b) includes non-forested areas but you would like to rely solely on references to the Carbon White Paper rather than repeating here}.

Non-forested ecosystem types (such as rangelands) are an important source of long-term ecosystem carbon storage. Rangelands are dominated by grasses, forbs, and shrubs, and include vegetation types such as grasslands, prairies, shrublands, deserts, wetlands, and riparian zones. In rangelands, most carbon is stored underground (Paruelo et al., 2010; Terrer et al., 2021; White, 2000). In these systems, soil organic carbon (SOC) constitutes approximately 80-95 percent of total ecosystem carbon (Adams et al., 1990; Meyer, 2012; Ontl & Janowiak, 2017; Reeves et al., 2020). SOC is recalcitrant and well protected from natural disturbances (e.g., fire), making it generally resistant to change (Spangler, 2011). SOC is therefore considered to be relatively stable, especially when concentrated below the top 30 cm of the soil profile (Reeves et al., 2020). Shrublands have a greater percentage of SOC stored in the soil profile below 1 meter while grasslands usually have most SOC in the first meter of soil (Meyer 2012; USDA FS 2013). Combined with high ecosystem resilience to climatic changes, including rising temperatures, drought, and fire, underground carbon pools in rangelands are generally unlikely to be emitted to the atmosphere (Booker et al., 2013; Dass et al., 2018; Paruelo et al., 2010; Terrer et al., 2021; White, 2000).

The net carbon balance in the soil is fundamentally determined by the balance between inputs (root and litter turnover) and outputs (decomposition) of soil organic matter (SOM) (Fynn et al., 2009). SOM content is dependent upon vegetation type, climate, soil type, parent materials, physiographic influences, and land use (Spaeth, 2020). Land management can increase or decrease soil carbon stocks, with sustainable management practices which increase SOM inputs or decrease loss from soil respiration potentially increasing soil carbon stocks (Spangler, 2011). These activities may include minimizing soil erosion, protecting soil aggregates, and promoting perennial vegetation retention and diversity (Tennigkeit & Wilkes, 2008). However, the impact of management practices can vary based on climatic characteristics, vegetation, and soil types, meaning sustainable approaches must be site-specific. Lastly, ecosystem changes can impact SOC storage in non-forested ecosystems. A shift from sagebrush shrublands to nonnative annual grasslands will eventually move carbon from deeper in the soil profile to the upper 20 cm (Qafoku, 2014). For example, an estimated 8 teragrams (Tg; 1012 grams) of carbon have been lost due to shrubland conversion to annual grasses, particularly cheatgrass (*Bromus tectorum*), in the Great Basin since 2006 (Meyer, 2012).

1.4 Purpose and Need of Project Related to Carbon Assessment

National forests and grasslands can play an important role in climate change mitigation. Balancing the numerous environment benefits, including carbon sequestration, provided by healthy ecosystems, is paramount to the Forest Service’s mission. The Forest Service principles of thoughtful carbon stewardship do not seek to maximize carbon at the expense of forest health, but rather, to assess carbon within the context of ecosystem integrity and climate adaptation.

As part of promoting balanced ecosystems on the National Forest name NF, management objectives of the Project name include:

- [insert list of project-specific management objectives]

These management objectives have been developed in response to past management and history of the National Forest name NF. [Describe past management actions which have led to the need for the project, if applicable. Cite relevant literature where appropriate.]. These actions resulted in the following conditions: [insert resulting conditions].

The management actions described in the Project name project assess carbon stocks alongside other ecosystem benefits. The anticipated impacts to carbon after the project has been fully implemented, over the lifetime of the project, include: [insert anticipated impacts to carbon]. Carbon [losses or gains] over short time frames may occur resulting from the following actions: [list project actions causing short-term carbon changes]. Long-term carbon [losses or gains] are expected due to [insert actions or processes leading to long-term changes in carbon]. Compared to the no action alternative, project actions are predicted to: [insert expected impacts of project actions on carbon]. [Final statement summarizing the project, impacts on ecosystem resilience, and carbon].

1.5 Issues Addressed

{See instructional template for more details on completing this section}

The Forest Service Handbook defines an issue as “a statement of cause and effect linking environmental effects to actions” (Forest Service Handbook 1909.15). The following issues pertaining to carbon emissions have been identified for detailed analysis:

Issue 1: [insert issues relevant to project, listing each individually]

1.6 Analysis Assumptions

For the purposes of this analysis, the following assumptions apply:

1. The data described in the following effects analysis is based primarily on the unit-level forest carbon data available in the Carbon White Paper for the National Forest name NF ([insert Carbon White Paper reference]).
2. Additional data on a finer scale are used if and when available to ensure the use of the reliable data, resources, and models for this analysis.

2.0 Methodology

{Delete any sections which do not apply to your project. Delete any methods that you did not use from specific sections and modify to fit your project and analyses. When emissions are quantified (such as in Harvest Option B, Fossil Fuel Emissions Associated with Biogenic Projects, use of BlueSky Playground, etc.), those emissions should typically be quantified using the social cost of greenhouse gas calculator. See the FS Step-Down Guidance for more information. Templated language for the social cost of GHG is not currently included in this template, as OSC does not provide support for those tools. However, carbon specialists can choose to include those results within their final carbon specialist report if calculated.}

This section includes a description of the methods and data used in this analysis. The Carbon White Paper for the National Forest name NF in the project record contains additional information on methodologies used to inform carbon data incorporated in the following analysis.

2.1 Harvest

The harvesting activities will remove [number] CCF of [volume category, such as industrial roundwood or roundwood] from [number] acres (Table 1). Project name project actions will be implemented over [number] years. For more details, see [insert reference to document with harvest details].

We estimate project-level effects of harvest on carbon, which we compare to national forest unit-level carbon stocks and fluxes. The national forest unit is the smallest spatial scale for which we have nationally consistent and accurate carbon estimates.

Table 1. Estimates of roundwood (sawtimber, pulpwood, and fuelwood) volume removals (hundred cubic feet, CCF) and area (acres) for proposed harvest alternatives. Other planned harvests include planned timber harvesting activities in the National Forest name NF which will overlap temporally, but not spatially, with the proposed project.

Class	Alternative A	Alternative B	Alternative C	Other planned harvests
Roundwood volume (CCF)				
Area (acres)				
CCF/acre				

Project-Level Effects {Option A}

{Option a relies on the data in the Carbon White Paper only. See instructional document for details on converting numbers in the Carbon White Paper into a project-specific estimate of carbon.}

Estimates of harvest effects on carbon are based on the Carbon White Paper [insert unit Carbon White Paper citation]. We used 20-year estimates of carbon per acre lost to harvest to estimate potential impacts of the proposed actions. This approach assumes that proposed alternatives have similar removal intensities to past management. Estimates are based on ForCaMF model results, which estimates carbon loss due to different disturbance categories based on remote sensing data. This method may overestimate carbon loss per area, as it does not account for carbon storage in harvested wood products, incorporates short-term reductions in stand growth rate following harvest, and may omit low-intensity disturbance, such as light thinning with little canopy impact. For more details, see the Carbon White Paper. We multiplied the project area by the carbon lost per acre harvested to estimate approximately 20-year potential carbon loss associated with each proposed alterative.

Project-Level Effects {Option B}

{Option B is a more in-depth analysis, appropriate for projects receiving comments on carbon impacts or when the potential carbon impacts are larger. Instructions are available for this approach in the OSC Carbon SharePoint site, in a subfolder labeled PLACE within the NEPA project template folder. When emissions are quantified, those emissions should typically be quantified using the social cost of greenhouse gas calculator. See the FS Step-Down Guidance for more information.}

Project-level carbon emissions associated with harvest are based on the Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory (Murray et al., 2024) and the associated excel-based “level I” quantification workbook (tool) (Stockmann et al., 2024), published by the USDA. Estimates include total forest carbon transfers, HWP storage over time, net harvest atmospheric carbon emissions based on 100-year HWP storage (in use and in landfill), and maximum potential substitution benefits from substituting harvested wood products in the place of fossil fuel-based energy or other more energy-intensive products. In the tool, we entered total volume and acreage estimates for [include all specified parameters, potentially including forest type, stand age, regeneration origin, wood type, log type]. We used regional averages within the tool to estimate [include all parameters not specified and for which you used “unknown” categories in the model, potentially including forest type, stand age, regeneration origin, wood type, and log type]. For harvested wood product life cycling, we used the default chi-squared option, which offers more realistic product decay patterns compared to the traditional exponential decay.

Lost Growth Potential of Removed Trees {Option B – Supplementary Analysis}

{This section is optional and only potentially applies if the optional project-level analysis using the Entity Guidelines tool (Option B) is used. This analysis may be appropriate if you receive questions about how the stand- level growth rate is impacted by harvesting activities.}

To estimate short-term (20 years) lost growth potential, we used the Entity Guidelines tool to estimate future growth in the project area with and without harvest. We analyzed a 20-year projection since the Entity Guidelines tool has reduced confidence in estimates beyond 20 years, given high uncertainty around future climate and disturbance changes. To estimate growth in unharvested areas, we kept all parameters exactly the same as for the project level analysis, using the basic forest projection functionality within the tool. To estimate growth rates in harvested areas, we used the same parameters as for the project level analysis but changed stand age to 0-20 years. For harvests which involve partial volume removal, we assume that the percentage of biomass removed equals the percentage of area cut. Therefore, we used the percentage of biomass removed to estimate the areas of the project area which would follow a regeneration versus continued growth trajectory. We weighted the estimates and summed to estimate growth following harvest. We then compared expected growth in the absence of and following harvest to calculate the lost growth potential.

2.2 Prescribed Fire and/or Fuels Reduction

The prescribed fire and fuels reduction activities will be implemented over [number] acres and [number] years. For more details on proposed activities, see [document with more details, e.g., fire specialist report].

{Optional; Refer to the FS guidance section titled "Projects that reduce fuel loads" and in Appendix B for instructions on using this optional tool if you decide to use it.} We used Blue Sky Playground (https://info.airfire.org/playground) to calculate carbon emissions (in the form of carbon dioxide, CO_2) for Project name project related to prescribed burning. The models within the BlueSky Playground are enabled by the BlueSky Framework supported by the USDA Forest Service's AirFire suite of tools.

2.3 Prescribed Fire or Harvest for Restoration

The prescribed fire or harvest for restoration activities will be implemented over [number] acres and [number] years. For more details, see the [insert relevant] specialist report.

{Optional; Refer to the FS guidance section titled "Projects that reduce fuel loads" and in Appendix B for instructions on using this optional tool if you decide to use it.} We used Blue Sky Playground (https://info.airfire.org/playground) to calculate carbon emissions (in the form of carbon dioxide, CO_2) for Project name project related to prescribed burning. The models within the BlueSky Playground are enabled by the BlueSky Framework supported by the USDA Forest Service's AirFire suite of tools.

2.4 Rangeland Management, Improvements, and/or Permitted Livestock Grazing

The proposed activities will be implemented over [number] acres and [number] years. For more details, see the rangeland specialist report. Our assessment of the carbon impacts of rangeland activities draws on our Carbon White Paper and additional region- and ecosystem-specific scientific literature.

2.5 Restoration of Disturbed Ecosystems

The restoration of disturbed ecosystems will be implemented over [number] acres and [number] years.

The proposed action targets the removal of [insert invasive species]. This invasive species impacts approximately [number] percent of National Forest name NF. This project targets [number] acres of the National Forest name NF where the species occurs. [Insert invasive species effects on habitat and woody structure]. This project involves the removal of [invasive species] by [describe management activities].

For more details, see [pertinent documents]. Our assessment of the carbon impacts of restoration activities draws on our Carbon White Paper as well as region- and ecosystem-specific scientific literature.

2.6 Fossil Fuel Emissions Associated with Biogenic Projects

{Optional; many biogenic projects may not need to complete these calculations. When emissions are quantified, those emissions should typically be quantified using the social cost of greenhouse gas calculator. See the FS Step-Down Guidance for more information.}

The fossil fuel emissions related with biogenic projects involve construction of [number] miles of new road, [number] hours of various harvesting equipment. For more details, see the [insert relevant specialist report name] specialist report. These activities will occur over [number] years.

We used a calculator based on data from the latest version of the Environmental Protection Agency's Motor Vehicle Emissions Simulator, the 2022 EPA Automotive Trends Report, and AP-42 Compilation of Air Pollutant Emissions Factors. With this calculator, we estimated fossil fuel emissions from heavy machinery, tools, vehicles, hauling, and downstream emissions required to complete the project. For emissions associated with yarding and hauling timber, we used a calculator based on data from several timber sales nationwide, run through a model to determine the estimated fuel usage for the sales as planned. This provides an estimate of fuel usage per 100 cubic feet of timber (CCF), translated into CO_2 emissions based on fuel usage and fuel type.

3.0 Compliance with Land and Resource Management Plan

{*Most* Land and Resource Management Plans will not have specific climate or carbon guidelines. **Therefore, this section will most often be removed**.}

The National Forest name Forest/Grassland Land Management Plan provides standards and guidelines for carbon emissions.

{Repeat for each pertinent standard.}

[Pertinent land management plan standard or guideline]

[Unit-wide or management-area specific?]

[Relevant action or proposed activity]

[Consistency and rationale: Demonstrate how the proposed activities will comply with each standard, guideline, or direction referencing applicable design elements included in the proposed action. If your project includes multiple alternatives, address each alternative in this section.]

3.1 Special Area Designations

{If applicable, describe how the project is consistent with any relevant special area designations (for example, wilderness, research natural areas, or wild and scenic rivers). If none applies to your resource area and the project area or proposed activities, **remove this section.**}

4.0 Analysis Boundaries: Expected Lifetime of the Project Action

{Choice of spatial boundary is up to the discretion of the specialist completing the report. Direct, indirect, and cumulative boundaries may be different.}

[List project activities] are proposed within the [EMAs, districts, etc. of the project area] ecosystem management areas (EMAs). However, this specialist report considers the carbon stocks, fluxes, and drivers at National Forest name NF unit level, which is the smallest spatial scale with nationally consistent and accurate estimates. Therefore, the spatial analysis area for direct and indirect carbon effects are the forested lands within the National Forest name. The spatial boundary for cumulative effects consideration is the [ecoregion, state] because [rationale such as climate adaptation goals, collaborative landscape management plans, Wildfire Crisis Strategy Landscape, etc.].

The proposed treatments will be implemented over [number] years, which is the temporal boundary for direct, indirect, and cumulative effects consideration.

5.0 Affected Environment

5.1 Forest Carbon Dynamics

{Numbers in this paragraph come from Section 2.1 of the Carbon White Paper (CWP)} Based on CCT analysis in the Carbon White Paper, forested area in National Forest name has [increased/decreased/stayed constant] from [number] ha in 1990 to [number] ha in 2020, a net change of [number] ha. Carbon stocks on the National Forest name NF have increased from [number] ± [number] tetragrams of carbon (Tg C) in 1990 to [number] ± [number] Tg carbon in 2020, a [number] percent increase over this timeframe. The net annual uptake of carbon is [number] Tg/year. The trends observed in the National Forest name NF result in its categorization as a [insert category] carbon density forest ([insert Carbon White Paper citation]). In the National Forest name NF, CCT estimates that the largest carbon stock is [insert category], storing [number] percent of total forest ecosystem carbon, followed by [insert second largest category] storing [number] percent ([insert Carbon White Paper citation]). However, soil carbon stocks are likely larger than estimated, as CCT uses outdated FIA soil carbon and biomass equations. Soil carbon is typically one of the largest and more stable carbon pools within a forest (Domke et al., 2017; McKinley et al., 2011). The USDA FS Office of Sustainability and Climate - in partnership with Research & Development - is in the process of updating these stock and flux numbers, which will be available in April 2024.

5.2 Rangeland Carbon Dynamics

The National Forest/National Grassland name NF contains [number] acres of rangelands. The rangelands of the National Forest/National Grassland name NF are predominantly comprised of [type] vegetation, accounting for approximately [number] percent of the total area of the NF. The project area includes [number] acres, [number] percent of total forest rangelands.

Currently, 50 percent of non-forested lands administered by the Forest Service are classified as in moderate, poor, or very poor condition (Terrestrial Condition Assessment, 2022). In the Region Name Region specifically, over [number] acres of non-forested ecosystems are in [insert class] condition (Cleland et al., 2017) due to past and/or present land use and disturbance factors. Once lost, rangeland carbon is difficult to restore, with recovery potentially taking decades to centuries (Baer et al., 2002; Burke et al., 1989), if at all. This extensive recovery period highlights the need to manage and maintain current rangeland carbon pools.

{Optional; this data may not exist for your unit. You can optionally replace with qualitative information from your Carbon White Paper.} Most rangeland carbon is stored underground as SOC. In the National Forest/National Grassland name NF, [number] percent of the carbon stock is stored in aboveground live vegetation, and [number] percent of the carbon stock is stored below ground as SOC. Exact percentages may vary, as carbon stock values are estimated using a model-based approach which leverages existing vegetation coverage data layers (e.g., LANDFIRE) and data sources (e.g., SSURGO and STATSGO) for estimating SOC (Reeves et al., 2020).

5.3 Factors Influencing Forest Carbon

Historical land use impacts the carbon legacy of the National Forest name NF, including pre-historically documented land uses, Native American land management practices, Euro-American settlement, and current land management and disturbances. With European settlement came increased timber extraction, mining, grazing, and other impacts. [Add any pertinent land history from your Carbon White Paper, typically in section 1.7 of the CWP]. Past disturbance dynamics, forest regrowth and recovery, and forest aging have contributed to carbon trends.

Carbon sequestration and stocks vary with stand age, with younger to middle aged stands generally having high sequestration rates and low total carbon stocks, and older stands having lower sequestration but higher total carbon stocks ([insert Carbon White Paper citation]). In National Forest name NF, most tree species peak in net primary productivity (NPP) between ages [insert range; Figure 8 in the CWP] before decreasing then stabilizing or continuing to decrease. Over [insert proportion; can be found in Forest Level Disturbances table on the carbon dashboard, https://public.tableau.com/app/profile/usda.forest.service/viz/Carbon_Dashboard_Public_17056983339290/Dashboard] of the stands in the National Forest name NF are middle-aged and older (greater than 80 years). There has been a sharp decline in new stand establishment in recent decades (Birdsey et al., 2019). If the National Forest name NF continues this trajectory, stand-level growth will decline in the coming years, potentially causing the rate of carbon accumulation to decline. However, ecosystem carbon stocks may increase for decades, as dead organic matter and soil carbon continue to accumulate.

{Numbers come from Section 3 of the CWP} Disturbance and climate are also important drivers of carbon dynamics. In National Forest name NF, [Insert disturbance type] was the largest disturbance driver of carbon stock change from 1990-2011 ([insert Carbon White Paper citation]), reducing carbon stocks by [number] percent compared to a scenario without disturbance. [Insert second largest disturbance type] was another key driver of carbon dynamics, reducing carbon stocks by [number] percent over the same period. Climatic changes have also affected carbon stocks in National Forest name by [describe climate impacts]. Forests have generally responded [indicate response] to nitrogen deposition and [insert response] to carbon dioxide fertilization. Overall, the carbon stock reduction caused by disturbances and climate conditions have been [describe impact] and offset by [describe mitigating factors].

Management aimed at increasing ecosystem stability generally provide carbon benefits by promoting long-term ecosystem carbon stability. Appropriate management activities vary by forest type, region, and climate. In the Region Name, practices which promote carbon stability include [insert adaptation practices for common forest types relevant to the project].

5.4 Factors Influencing Rangeland Carbon

Annual fluctuations in productivity caused by yearly rainfall or other patterns influencing annual grasses impact rangeland carbon stocks less than the long-term, overall resilience and productivity of these systems (Spangler, 2011). Despite the relative stability of soil carbon, rangeland carbon stocks can fluctuate with variations in environmental conditions, species composition, disturbance, and management practices (EPA, 2023; Spangler, 2011). Present-day rangelands are highly vulnerable to human disturbance (i.e., introduced species, overgrazing, and land-use conversion to agriculture) and climate change (Noss & Scott, 1995). For example, there may be seasonal or growing season grazing utilization thresholds which promote maintenance of soil organic carbon, which can be influenced by precipitation patterns (Derner & Schuman, 2007). Additionally, the timing and rotational nature of grazing must be considered to accommodate regeneration of palatable species (Gadzia & Sayre, 2009).

Research suggests that the following management practices are important to maintain and/or increase carbon sequestration on rangelands (both in above ground biomass and in the form of SOC):

- Stabilizing and restoring degraded areas (e.g., seeding areas of low vegetation density with perennial plants).
- Improving/maintaining rangeland health through planned grazing management practices by matching timing, duration, frequency and intensity to ecological conditions and objectives.
- Facilitating grazing management and livestock distribution by developing structural rangeland improvements (e.g., fences, water facilities).

- Reducing shrub and/or tree encroachment based on site potential.
- Controlling invasive annual species.
- Improving/maintaining rangeland health using prescribed fire.
- Application of soil amendments such as biochar or fertilizer.
- Avoiding disturbance such as cultivation and land conversion.

5.5 Future State

The future carbon state of the project area in the absence of proposed activities will be impacted by climate change. Climate change will have significant impacts on forests through the next century, including changing establishment and composition ([insert your regional adaptation assessment]). Changing temperature, precipitation, and disturbance factors, including fire, insects, and disease, will increasingly stress forested ecosystems. A full summary of expected climatic changes to the National Forest name is located within the Carbon White Paper ([insert Carbon White Paper citation]).

{You can pull this information from section 4.2 of the CWP, or vulnerability assessments can be found here: https://usfs.maps.arcgis.com/apps/Cascade/index.html?appid=f09164baef5d47d3ad728deaa1a28e7b} The Climate Change Vulnerability Assessment of [insert report region] ([Insert report citation]) encompasses the National Forest name NF [insert vulnerability report citation]. The report indicates that temperature is projected to [describe temperature changes]. Meanwhile, precipitation is projected to [describe precipitation changes, including drought]. These changes would [describe impacts on forest structure and composition, including at-risk tree species]. As a result, long-term carbon stocks may [describe anticipated carbon effects]. Climatic changes may have interactive effects with disturbance, further impacting carbon. For example, drought-stressed trees may also be more susceptible to insects and pathogens (Dukes et al., 2009), which can reduce carbon uptake (D'Amato et al., 2011; Kurz et al., 2008).

{Forest health advisory system information can be found here: Forest Health Advisory System (usda.gov); this information is also summarized in section 4.2 of the CWP} Changing disturbance is likely to impact future stand dynamics within National Forest name NF. Damage from native insect species via climate-related changes in insect life-cycle attributes and reduced forest vigor may be one of the most prominent effects of a warming climate (Vose et al., 2018). According to the Forest Health Advisory System, [number] acres of National Forest name NF are susceptible to high level (>25 percent) of overall tree mortality, with [number] percent of the tree biomass is at risk to forest pests (https://apps.fs.usda.gov/fhas).

Changes to fire regimes, including frequency and intensity, may also change in the region. [Describe anticipated changes, with regional literature, which is likely summarized in section 4.2 of the CWP].

{Optional paragraph; remove if there are no rangelands in your project area.} These changing climatic and disturbance regimes will also impact rangelands. Rangeland productivity may increase with rising CO_2 (Terrer et al., 2021). However, as with forest ecosystems, climatic shifts may also change individual species distributions and site suitability, causing compositional shifts. Future changes to wildfire regimes may also have impacts on rangeland carbon, with decreased fire frequency potentially enabling woody encroachment (which has been shown to have mixed impacts on SOC depending on biome) and high frequency fire potentially inhibiting regeneration.

Therefore, in the absense of the project, the affected environment will likely [describe future conditions, summarizing from above and emphasizing likely overall changes to the unit].

6.0 Direct, Indirect, and Cumulative Effects of the No-Action Alternative

In the no action alternative, the project area will [summarize impacts of not implementing the project, such as loss of resiliency and the impacts on carbon]. As mentioned in Section 5, the project area is likely to experience [briefly summarize climate change impacts]. [Incorporate any unit-specific data, such as from stand exams or burn severity mapping, to add nuance to this discussion. Describe ongoing management that will continue outside the scope of the project.] Therefore, while short-term carbon stocks are likely to continue to increase under a no-action scenario, there are long-term risks of reduced carbon stocks, as a result of [describe how taking no action will affect ecosystem stability or other consequences]. Therefore, the no action alternative will result in [summarize overall impact to carbon stocks or sequestration].

7.0 Direct, Indirect and Cumulative Effects of the Proposed Action

{See instructional document for high-level overview of considerations for this section}.

The proposed Project name project includes [list project activities] on approximately [number or range for multiple alternatives] acres of the National Forest name NF. This scope and degree of change would affect a maximum of [number] percent of the [number] acres of forested land in the National Forest name.

The effect of the proposed action focuses on the aboveground living carbon pool, which comprises about [number] percent of the total ecosystem carbon stocks of the National Forest name ([insert Carbon White Paper citation]).

7.1 Harvest

Under the no-action alternative, the forest stands in the project area will likely thin from disturbance, competition, and age, resulting in dead trees that decompose over time and release carbon. Under the proposed harvest project alternatives, wood and fiber removed from the forest will transfer to the wood products sector as various commodities which have different residence times as in-use products (Skog et al., 2014; Murray et al. Pending). Wood can also be used in place of other materials that emit more GHGs, such as concrete, steel, and plastic (Gustavsson et al., 2006; Lippke et al., 2011; McKinley et al., 2011), or burned to produce heat or electricity in place of fossil fuel combustion, which are considered substitution effects. Thus, managing forests with a harvested wood product component may result in lower net contribution of GHGs to the atmosphere than if the forest were not managed (Bergman et al., 2014; McKinley et al., 2011; Skog et al., 2014). The IPCC recognizes wood and fiber as a renewable resource providing lasting climate-related mitigation benefits that can increase over time with active management (IPCC, 2000, 2006).

{Option A} [Summarize how harvest prescriptions increase resiliency to major future forest risks]. These benefits are balanced by a temporary decrease in aboveground carbon stocks. However, ecosystem carbon losses associated with harvest have been relatively small compared to the total amount of carbon stored in the forest. Based on the information from our Carbon White Paper, we expect that the project will transfer [lower number – upper number] tonnes CO_2eq from the forest ecosystem over approximately two decades. This estimate represents an upper bound for losses because they do not account for continued storage of harvested carbon in wood products or the effect of substitution of wood and biomass utilization for higher GHG-emitting materials or energy sources.

{Option B: subsequent two paragraphs and table. Delete if using Option A.}

[Summarize how harvest prescriptions increase resiliency to major future forest risks]. These benefits are balanced by a temporary decrease in aboveground carbon stocks. Based on our analysis, we expect that the project will remove [lower number – upper number] tonnes CO_2eq from the forest ecosystem (Table 2). However, this number is greater than the actual atmospheric emissions because of continued carbon storage in harvested wood products. Based on 100-year storage of HWP, the estimated atmospheric emissions are [lower number – upper number] tonnes CO_2eq (Table 2).

The proposed alternatives have a maximum substitution potential of [lower to upper number] tonnes CO_2eq (Table 2). Although these values are close in magnitude to the total biogenic CO_2eq emissions, we do not add maximum substitution potential (which is negative as it represents atmospheric carbon avoided emission) with harvest-related carbon emissions for two key reasons. First, potential substitution impacts occur outside the system boundaries of the Intergovernmental Panel on Climate Change (IPCC) estimation protocols for forest carbon flux (ecosystem and HWP). Secondly, there is uncertainty about the true amount of displacement or substitution occurring. Factors such as additionality (quantifying the actual change in carbon emissions occurring as a result of proposed activities) and leakage (the potential for fossil fuel use to be shifted outside of the system boundary as a result of the substitution) must be included for full accounting and are not factored into our estimates. Thus, these estimates indicate the upper bounds of the potential for the HWP sector to offset carbon flux related to harvest.

Table 2. Estimates of carbon transfers and maximum substitution potential based on analysis using the Entity Guidelines tool.

	Alternative A	Alternative B	Alternative C	Other planned harvests
	All in tonnes CO_2eq			
Project-level biogenic carbon transfers				
Total harvest transfer				
Carbon storage, HWP in use/in landfill, year 100				
Cumulative net harvest emissions, project timeline				
20-year reduced growth potential {optional row/analysis}				
Maximum substitution potential				
Products				
Bioenergy ([insert category])				
Total				

{Option B – Supplementary analysis. Delete if using Option A or if you did not complete this optional analysis for Option B.} If we make the simplifying assumption that growth rates in harvested areas will reflect biomass trends of new stands, and the uncut trees will continue to grow as usual [if using this for heterogenous harvests such as thinning, insert caveat that this may underestimate growth release of residual trees], reduced growth rates may result in a reduction of potential stored carbon equivalent to [lower number – upper number] tonnes CO_2eq lower compared to an uncut scenario over a 20-year period (Table 2). Over the long term (e.g., 50-100 years), growth rates of cut areas will likely surpass and eventually approximate those of an uncut stand, based on functions of net primary productivity versus age ([insert Carbon White Paper citation]).

{Numbers will be in Mg/Tg of carbon or CO_2eq for Options A and B, respectively. For Option A, see instructions to calculate these values; for Option B, these values can be found in the PLACE tab of the Entity Guidelines excel workbook}. The estimated harvest-related emissions are much smaller than our certainty around key unit-level carbon pools. For example, the live aboveground carbon in National Forest name NF is [number and units] ([insert carbon white paper citation]); due to uncertainty in estimating based on a finite sample of plots, we assume that the true mean falls within a confidence interval, equivalent to the estimate plus or minus 1.96 standard errors. For aboveground live carbon, one standard error is [number and units]. In other words, the true aboveground live carbon pool mean likely falls within [confidence interval lower range – upper range numbers and units]. In [insert alternative identification] which has the greatest [emissions if using Entity Guidelines OR transfer if using Carbon White Paper] of [number and units], subtracting that value from the current total aboveground live carbon pool would result in an estimate [number and units], which [describe comparison of the two, e.g., is smaller or larger than a standard error]. It is important to note that this calculation is a simplification to show the impact proposed harvests would have on total carbon. Other dynamics, such as other planned harvests, disturbance, and climate change, would be ongoing as well as net carbon sequestration, which will all affect overall estimates of future carbon stocks.

{See instructions document to complete table 3 for Option A; Option B has instructions in the PLACE folder} Based on the simplified assumption that all harvests occur simultaneously and using the estimated rate of net forest carbon uptake from the carbon white paper, National Forest name NF would sequester the amount of carbon [emitted for Option B/transferred for Option A] by the harvesting alternatives within [lower number – upper number] months (Table 3). Proposed harvests remove less than [number] percent of aboveground National Forest name NF carbon, and less than [number] percent of total National Forest name NF carbon (Table 3).

Table 3. Calculations to contextualize the impacts of harvest actions on unit-level carbon stocks. Time to recover [transferred/emitted] carbon makes the simplifying assumption that all harvests occur simultaneously.

Metric	Units	Alternative A	Alternative B	Alternative C	Other planned harvests
Time until net growth recovers [Option A: transferred; Option B: emitted] carbon	Months				
Percentage of total National Forest aboveground carbon emitted	Percent				
Percentage of total National Forest ecosystem carbon emitted	Percent				

7.2 Fire Regime Management via Prescribed Fire and/or Fuels Reduction

{Numbers from section 2.1 of the CWP} Carbon emissions associated with prescribed fires come mainly from combustion of duff, litter, and small-sized dead wood which would otherwise decay and release carbon even in the absence of fire. The project's prescribed fire treatments will primarily affect understory and forest floor carbon pools. Together, these pools comprise about [number] percent of the forest-wide ecosystem carbon stocks. However, we cannot use unit-level averages to estimate project-level potential carbon impacts from prescribed fire due to spatial and temporal heterogeneity in the distribution of fuels and variability in prescribed fire fuels consumption. About [number] percent or more of the ecosystem carbon is in mineral soils, a very stable and long-lived carbon pool (McKinley et al., 2011; USDA Forest Service 2015; Domke et al. 2017) that is generally not impact by fire (Nave et al., 2011).

[Based on Carbon White Paper, describe historic and fire regimes and impacts on current stand dynamics for your region. For example, fire suppression can lead to larger and more frequent fires in the western US due to fuel build-up versus mesophication and oak regeneration decline in the eastern US]. In the absence of actions to reduce stand density and fuel loads, the project area may be more at risk to [describe negative consequences and insert pertinent citations from Carbon White Paper, typically increased risk of high intensity fire] than under the no action alternative. [Discuss details of negative consequences of no action, such as higher risk of high intensity fire and loss of carbon stability or ecosystem shifts and regeneration failure]. This may result in decreases in ecosystem services, such as [list ecosystem services, including effects on ecosystem carbon stocks]. By reducing the threat of [negative consequences from no action], the project would create more advantageous conditions to support forest resiliency and carbon stability, thereby promoting carbon stewardship.

Prescribed fires tend to target surface and ladder fuels and are typically less severe than wildfires (Agee & Skinner, 2005; Hunter & Robles, 2020) since they are conducted only when weather conditions are optimal and fuel moisture is high enough to keep combustion and spread within predetermined limits. Thus, prescribed fire typically results in limited overstory tree mortality and limited combustion of available fuel (Carter & Darwin Foster, 2004; Hurteau & North, 2008; Waldrop & Goodrick, 2012). This produces lower GHG emissions than if the same area burned in a high-severity wildfire (Wiedinmyer & Hurteau, 2010). A large portion of emissions associated with prescribed fire is from duff, litter, and dead wood, which comprise carbon pools that decay quickly over time and release carbon to the atmosphere. [Describe design features of project which address these risks].

For the proposed activities, total carbon losses from 1990 to 2011 due to fire are equivalent to about [number] percent of non-soil carbon stocks. The methods used to quantify the effects of fire on carbon stocks do not differentiate between prescribed fire and wildfire. Based on unit-specific information, [discuss any unit-specific records of fire or prescribed fire, including mentioning of any very large fire events and the overall balance between prescribed and wildfire in your unit]. [Discuss any information on significant fires after 2011, such as acres burned, using unit-specific information available.] Therefore, we anticipate [describe how project will likely affect future carbon dynamics, including lessening likelihood of large wildfires observed in the past or continuing similar carbon trends if the history is likely indicative of past managed low-intensity fire.]

{Optional if BlueSky Playground was used} According to BlueSky Playground, [number] Tg of CO_2 will be emitted from the project fuel treatments. After this temporary increase in carbon emissions, we expect long-term carbon stocks to be more stable under future climate conditions.

Overall, the prescribed burning actions involved in the project may result in temporary increases in carbon emissions but will lead to longer term stabilization of carbon stocks with more frequent disturbance given projected future climate conditions.

7.3 Restoration via Prescribed Fire or Harvest

Some tree species and forest communities within the Region Name Region are well adapted to fire and in some cases may depend on it for survival and regeneration, including [insert examples for your project, with notation "common name (*Genus species*)"]. [Describe pertinent fire history for your region based on information in the Carbon White Paper.]. By [describe mechanism of project activities, such as reducing vegetative competition in the understory or influencing seed establishment], the proposed prescribed fire after harvest would [describe regeneration and stand structure outcomes]. This would support forest resilience in a changing climate and reduce long-term GHG emissions.

{Number from section 2.1 of the CWP} Carbon emissions associated with prescribed fires come mainly from combustion of duff, litter, and small-sized dead wood which would otherwise decay and release carbon even in the absence of fire. The project's prescribed fire treatments will primarily affect understory and forest floor carbon pools. Together, these pools comprise about [number] percent of the forest-wide ecosystem carbon stocks. However, we cannot use unit-level averages to estimate project-level potential carbon impacts from prescribed fire due to spatial and temporal heterogeneity in the distribution of fuels and variability in prescribed fire fuels consumption. Initial carbon emissions from the project will also be balanced through stand recovery and regeneration, because remaining and newly established trees typically have higher rates of growth and carbon sequestration (Dwyer et al., 2010; Hurteau & North, 2008; McKinley et al., 2011).

{Optional; refer to FS guidance, "Projects that reduce fuel loads" and Appendix B, for instructions on using this optional tool}. According to results from the BlueSky Playground, these actions would result in emissions of [number] tonnes of CO_2.While prescribed fires and fuels reduction projects result in an immediate decline in carbon ecosystem stocks, in the long term, ecosystem carbon stocks tend to stabilize. In the absence of a prescribed burn or fuels reduction project, the forest may be more susceptible to high severity wildfire that may result declining carbons stocks, creating a long-term stabilizing effect on carbon.

7.4 Rangeland Management, Improvements, and/or Permitted Livestock Grazing

Historically, rangelands were subject to naturally occurring disturbances, such as low-intensity wildfires (Zouhar, 2021) and ungulate grazing. Present-day rangelands are highly vulnerable to human disturbance (i.e., introduced species, overgrazing, and land-use conversion to agriculture) and climate change (Noss & Scott, 1995). Therefore, sustainable management practices must be site-specific.

{Optional if project includes grazing.} When managed properly, grazing can provide ecosystem services, such as fuel load reduction of rangelands, potentially decreasing probability of catastrophic wildfire and increasing carbon sequestration opportunities. Proper grazing management alone has been estimated to increase soil carbon storage on USA rangelands from 0.1 to 0.3 Mg carbon per ha per year (Schuman et al., 2002). Management approaches should be selected and designed in a manner that is relevant to the landscape needs and associated ecological potential to ensure realistic outcomes may be achieved and the actions are balanced with the other uses and resource needs of an area. [Describe how proposed grazing activities have been chosen to increase ecosystem health and any potential carbon impacts.]

{Optional if project includes prescribed fire} Prescribed fire is also an effective management tool for non-forested ecosystems. Fire is a fundamental ecological process in rangeland ecosystems (Scasta et al., 2023). The effects of fire on ecosystem properties are characterized often as first-order and second-order fire effects. First-order fire effects occur during the fire and include biomass consumption, soil heating, and smoke production. Second-order fire effects include interactions with many other non-fire factors that influence post-fire ecosystem responses, typically over longer time periods, such as vegetation succession and changes in vegetation productivity. Second-order fire effects ultimately influence overall rangeland health.

Rangeland improvement can have significant carbon benefits. Management practices that reduce soil disturbance, implement proper grazing and prescribed fire techniques, and increase native species coverage can enhance soil carbon inputs by increasing plant productivity and limiting soil carbon losses (Ontl & Janowiak, 2017; Reeves et al., 2020). Management objectives and activities on the National Forest name NF strive to minimize soil disturbance and promote species diversity. This is seen in applying grazing management approaches that are appropriate for the plant communities present and the objectives hoped to be achieved. [Describe how the project is appropriate for the site. For example, rotational grazing provides periods of rest from grazing, during which plants develop more extensive root systems which increase carbon; managing livestock use in and around sensitive areas (e.g., highly erosive soils, critical habitat, etc.).]

Therefore, we expect that proposed activities of [insert activities] will have [describe trend] impact on carbon. Long-term carbon trends will likely [describe trend and mechanism, likely related to increasing ecosystem resilience or stability].

7.5 Restoration of Disturbed Ecosystems

Restoration

Habitat restoration, including reforestation, can result in long term increases to carbon stocks in forest ecosystems. Both natural regeneration and tree planting can assist in post-disturbance recovery of forest ecosystems (USDA Forest Service, 2022). The Forest Service has internal directives and guidance related to management activities for maintaining, regenerating, and restoring forest cover, including reforestation. Managed reforestation following disturbance events can enhance carbon ecosystem functions by increasing woody biomass and sequestration rates, with immediate and long-term carbon benefits. Where agricultural lands are converted to forest via reforestation, carbon sequestration in topsoil increases significantly (Nave et al., 2019). In the United States, reforested lands occupy more than 500,000 km^2. Within a century, these lands are projected to sequester 1,300-2,100 Tg carbon (Nave et al., 2018). In addition to carbon sequestration benefits, reforestation can provide additional wildlife habitat, forest wood products, and opportunities for recreation (Nave et al., 2019).

{Seedlot Selection Tool is a helpful planning resource: Seedlot Selection Tool}The distribution of plant species is largely determined by climate, with research showing that plant distribution is expected to change in response to a changing climate (Hill & Field, 2021). Therefore, it is important to understand how species ranges may expand or contract under a changing climate. Species and seed origin in restoration or reforestation projects should be selected to adapt forests to near-term and potential future climatic conditions (USDA Forest Service, 2022). To that end, seed selection for the proposed action was based on [main anticipated climatic changes] for this Region.

{Optional, if project includes non-forested areas} Rangeland restoration can also increase carbon sequestration rates. Restoring agricultural lands to perennial grass cover has been shown to sequester as much as 0.6 Mg carbon per ha per year (Schuman et al., 2002). Therefore, project efforts aimed at active restoration will likely increase carbon stocks in National Forest name NF.

Therefore, we anticipate that project activities will have a [describe trend] impact on carbon stocks of the National Forest name NF.

Invasive Species Removal

Invasive species are a major threat to the health, sustainability, and productivity of native ecosystems (Poland et al., 2021). Impacts from invasive species in terrestrial ecosystems include alterations to species abundance and distribution, fire regimes, belowground biotic and abiotic process, and availability of resources to native species. Invasive plants also impact primary productivity and nutrient cycling and frequently accelerate carbon cycling. Invasive plant species effects on ecosystem carbon stem from traits of the invading and resident species as well as environmental conditions (Poland et al., 2021).

{Optional; remove if no grasslands in project area} In rangelands, removal of invasive species such as invasive annual grasses can enhance soil and plant carbon stocks. Invasive grass species and exotic annual typically have fewer and shallower root systems, therefore storing less carbon in the soil. By outcompeting native species in rangelands, invasive annual grasses and forbs may result in decreased species diversity, lower productivity, fewer soil carbon inputs, and shifts in SOC from lower (i.e. more protected) to higher soil horizons (Germino et al., 2016; Rau et al., 2011; Reeves et al., 2020). Both aboveground carbon stocks and soil organic carbon stocks have been found to be significantly lower following transitions to invasive cheatgrass from shrublands or sagebrush steppe vegetation (Bradley et al., 2006; Meyer; Reeves et al., 2020). Native and diverse grassland species, therefore, are critical in maintaining the health and carbon sequestration capacity of rangelands.

Therefore, our proposed management activities of [describe project actions] may [describe trend] carbon sequestration by reducing invasive species coverage via [describe mechanism affecting carbon stocks, such as release of native vegetation from competition or altering rooting material]. Carbon benefits resulting from restoration will vary by location and project. Furthermore, critical ecosystem services beyond carbon sequestration are typically achieved by restoring ecosystems. Those may include improvement of functional water catchments and delivery of clean water, food production, critical wildlife habitat protection, and biodiversity enhancement (Delgado et al., 2011; Sanderson et al., 2013; Schuman et al., 2002). In the long-term, increased ecosystem resilience and health as a result of project actions are likely to increase stability of ecosystem carbon under changing climates and disturbance regimes.

7.6 Fossil Fuel Emissions Associated with Project Implementation

The following are sources of fossil fuel emissions associated with project implementation: [e.g., yarding and hauling timber, road construction, etc.] Based on the calculator described in Section 2.6, we estimate that [number] tonnes of CO_2eq will be released to the atmosphere as part of implementing the project.

7.7 Cumulative Effects of the Proposed Action

{See instructional document for high-level guidance on points for consideration.}

Annual and recurring management which could contribute to cumulative impacts to carbon include the proposed project as well as past and reasonably foreseeable projects within the spatial and temporal boundaries described in Section 4.0. Effects from other projects within the action area could include future fuel treatments, timber harvest, and other treatments affecting biogenic carbon.

Section 5 contains an overview of the key past drivers of carbon trends to the present. [Briefly review information from section 5, including patterns of carbon stocks (including present carbon distribution by pool), the relevant disturbance drivers of carbon, and projected climate climates.]

[Review the key about carbon impacts of the proposed activities, including long-term impacts on resiliency and stability]. In all alternatives besides the no-action alternative, the proposed project will [describe short-term carbon impact]. However, long-term carbon impacts are likely to be [describe trend].

[Describe any anticipated activities or carbon changes within the cumulative effects boundaries which are reasonably foreseeable and how they may impact short- and long-term carbon dynamics. You may consider including details of proposed activities within the National Forest. Describe how project activities will interact with other past, present, and reasonably foreseeable activities within the cumulative effects temporal and spatial boundaries to impact carbon dynamics.]

In 2021, the largest source of forest sector emissions in the United States was from the conversion of forest land to non-forest, with estimated losses of 144.4 MMT CO_2e (Domke et al., 2023; EPA, 2023). The proposed activities in the Project name project will not result in the loss of forest land from the National Forest name NF. In fact, forest health and long-term stability is enhanced by [describe how project activities increase resilience.] Without implementation of the proposed actions, it is possible that the forest area could experience a land cover type conversion (e.g., forest to rangeland) as a result of rapidly changing climate conditions. Some assessments suggest that the effects of climate change in some United States forests may cause shifts in forest composition and productivity or prevent forests from fully recovering after severe disturbance (Anderson-Teixeira et al., 2013), thus impeding their ability to take up and store atmospheric carbon[1] and retain other ecosystem functions and services.

The proposed actions are consistent with options proposed by the IPCC for minimizing the impacts of climate change on forests, thus meeting objectives for both adapting to climate change and mitigating GHG emissions (McKinley et al., 2011). They are also consistent with many existing carbon management strategies (Kaarakka et al., 2021; Ontl et al., 2020). These considerations are increasingly important as wildfire, drought, insects and disease, and combinations of disturbance types can reduce ecosystem carbon storage and alter ecosystem functions (D'Amato et al., 2011; Millar et al., 2007). [Describe the short-term and long-term effects on carbon; e.g., short-term carbon losses are balanced by long-term increases in carbon stability.]

8.0 Conclusion

[In a short paragraph (3 to 5 sentences), summarize your analysis above including any issues addressed, conclusions drawn, and consistency shown with the forest plan and other laws, regulations, and policies. This summary could include a comparison of multiple action alternatives if applicable.]

In summary, this proposed action is consistent with internationally recognized climate change adaptation and mitigation practices, as well as desired conditions within the National Forest name NF Land and Resource Management Plan. [Optional: Reference any additional regional, state, local, or tribal climate action goals that may apply to this project (such as Traditional Ecological Knowledge incorporated into the project planning, the Forest Service Climate Adaptation Plan or regional climate action plans); or others as appropriate. Units can refer to the spreadsheet of state-level climate action goals and should identify other relevant local climate or Tribal goals. The Climate Alliance database is another source for finding these goals.]

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[1] The term "carbon" is used in this context to refer to CO_2.

9.0 References

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