# Assessing the Greenhouse Gas Impacts of the Plum Creek Development Proposal in the Moosehead Lake Region of Maine

Environment Northeast

In 1998 the Plum Creek Timber Company purchased 900,000 acres of Maine woods from a major paper company in the Moosewood Lake region of northwestern Maine. Six years later, Plum Creek submitted plans for the largest subdivision in Maine's history. The Moosehead Lake region is part of the largest expanse of undeveloped woodland east of the Mississippi. The Plum Creek development proposal envisions up to 975 residential units, 1050 resort units (a mixture of single-family units, townhouse and apartment style units), 2 resort lodges, 190 employee housing units and 100 affordable housing units.

Environment Northeast (ENE) has prepared an assessment of the greenhouse gas emissions the proposed development would produce from land clearing, transportation and building energy use. .ENE's purpose in preparing this assessment is to raise awareness of the greenhouse gas impacts of the proposal—which are significant—and to recommend steps to reduce or avoid these impacts. Maine has made important commitments to reducing its greenhouse gas emissions, and stands to benefit from policies that would achieve these reductions. Its forests act as a major carbon sink and have the capacity to sequester large amounts of carbon through healthy tree growth. New markets for low carbon biofuels and biomass, coupled with payments to landowners to avoid deforestation and increase forest growing stock, could stimulate Maine's economy while helping the state meet its carbon reducing goals.

ENE's assessment, filed as testimony on behalf of GrowSmart Maine in proceedings at the Maine Land Use Regulation Commission (LURC), finds that:

- Forest Land Conversion -- between 387,378 and 501,081metric tons carbon dioxide ($CO_2$), of which roughly half is emitted to the atmosphere immediately (during development) and the other half is lost carbon storage potential over a 50 year period;
- Transportation -- emissions of approximately 9,566 metric tons $CO_2$ <u>each year</u>, equal to annual $CO_2$ production of approximately 1850 vehicles;
- Building energy -- emissions of at least 13,018 metric tons $CO_2$ <u>each year</u>.

Thoughtful employment of carbon mitigation measures could reduce these emissions and help achieve the state Climate Action Plan as well as the Regional Greenhouse Gas Initiative and other state and regional policy objectives. Improved development designs can shrink the amount of forest land conversion and soil disturbance and achieve a 41% reduction in total land area cleared compared to a conventional development design. If such a reduction were applied to the Concept Plan's residential development units alone it would deliver $CO_2$ savings of between 102,510 to 132,461 metric tons. The use of advanced building design can cost-effectively improve the energy efficiency of newly constructed buildings by as much as 50%. Such an improvement in the energy efficiency of new buildings could deliver dramatic cost savings to the building owner/operators and also reduce $CO_2$ emissions from oil heating by nearly 6,000 metric tons each year.

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**Testimony of Ellen Hawes, Policy Analyst – Forestry, Environment Northeast and**

**James Howland, Policy Analyst – Data Management and Energy Policy, Environment Northeast**

**In the Matter of Plum Creek Timber Company's Concept Plan Proposal for Moosehead Lake Region, Zoning Petition (ZP) 707**

**September 2007**

## I. Credentials

This testimony on the carbon emissions associated with the proposed project was prepared by staff at Environment Northeast (ENE). ENE is a Maine non-profit environmental research and policy organization that specializes in climate change solutions, sustainable energy policy and clean air in New England and eastern Canada.

The portions of this testimony addressing carbon emissions (or lost carbon sequestration) associated with forest land conversion, appearing in the Introduction and section III, were prepared by Ellen Hawes, Policy Analyst-Forestry at Environment Northeast. The portions of this testimony addressing transportation and building energy and the associated carbon emissions, appearing in the Introduction and in sections IV and V, were prepared by Jamie Howland, Policy Analyst-Data Management and Energy Policy at Environment Northeast.

**Ellen Hawes, Policy Analyst – Forestry**
**Environment Northeast (ENE)**

Ellen Hawes is lead policy analyst for ENE's forest carbon program and is based in ENE's Portland, Maine office. She received her Masters in Forestry from the Yale School of Forestry and Environmental Studies in December 2006. While at Yale, Ellen was a member of the Yale School Forest crew, helping manage 10,880 acres of forestland in Connecticut, New Hampshire, and Vermont, to meet silvicultural, ecological and educational objectives. Her research at Yale focused on analyzing trends in forest structure, health and ownership in the Connecticut and Pennsylvania Highlands Region. Prior to entering the Yale program, Ellen was Research Coordinator for the Climate Change Initiative of The Nature Conservancy where she helped coordinate a program to develop cost-effective ways to quantify carbon sequestration. Ellen also engaged in policy discussions internationally and domestically, working on rules for land use and forestry under the Kyoto Protocol and voluntary initiatives, such as the World Resources Institute and the World Business Council for Sustainable Development's Greenhouse Gas Protocol. Ellen received her BA *magna cum laude* in International Relations from Brown University in 2000.

**James Howland, Policy Analyst – Data Management and Energy Policy**
**Environment Northeast (ENE)**

Jamie Howland is policy analyst focusing on data management and energy policy at Environment Northeast. Jamie holds a Master of Environmental Management degree from the Yale School Forestry and Environmental Studies, where he focused on energy and the built environment. His research there included energy use in commercial and academic buildings, mobile-source pollution trends in vehicles, and non-market impacts on New England electricity prices. Jamie also holds an MBA and a BS in engineering from Rensselaer Polytechnic Institute and an MS in Engineering from Yale. He previously worked as a design engineer in the medical device industry and as a consultant for Hewlett Packard. He also served as an intern at Audubon International. Jamie works from ENE's Hartford, Connecticut office.

## II. Introduction

In 2003, the Maine legislature adopted and Governor Baldacci signed into law a directive for the Maine Department of Environmental Protection to:

> … develop a long-term climate action plan for the State that provides for a method for reducing greenhouse gas emissions:
>
> 1. To 1990 levels by 2010;
> 2. By at least 10% below 1990 levels by 2020; and

3. Ultimately, to a level that is 75% to 80% below 2003 levels. The plan must establish a date by which this reduction should be met.[1]

The act also directed the state to "lead by example" by, among other things, "conducting emissions inventories for state facilities and programs; obtaining voluntary carbon reduction agreements with private sector businesses and nonprofit organizations; participating in a regional greenhouse gas (GHG) registry; and establishing an annual statewide GHG emissions inventory."[2]

Key excerpts from the resulting state Climate Action Plan relevant to carbon emissions and sequestration in forests include the following (page citations noted in parentheses):

- A finding by the DEP that "the forest sector presents significant opportunities for carbon savings through sequestration." (p. 13);
- "Maine's is the first Climate Action Plan in the United States to fully consider the forest carbon cycle…" (p. 14);
- "[T]he total volume of carbon lost from forestland conversion to non-forest uses in Maine from 1990-2000 was 18.53 MMTC compared to growth in emissions from all sectors of about 22 MMTC during the same period. In other words, the carbon emitted from forestland conversion was almost as large as that of all other sectors combined. Fortunately, some of this was mitigated through afforestation and stand recovery, but the flow of carbon from forestland conversion appears to be significant." (p. 53-54).

While Plum Creek proposes to protect 386,000 acres of their lands through working forest easements, there is the potential for significant carbon emissions (or lost carbon storage) to occur on the areas that are converted from forest land during development.

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[1] 38 MRSA §576.

[2] Maine Department of Environmental Protection, Maine Climate Action Plan 2004: A Report to the Joint Standing Committee on Natural Resources of the Maine Legislature Pursuant to PL 2003 Chapter 237 December 1, 2004, p. iii, citing 38 MRSA §575.

## III. Carbon Loss from Converting Forest Land

Forests play an important role in the carbon cycle. Trees and other vegetation convert atmospheric carbon dioxide ($CO_2$) and store carbon in their aboveground and belowground biomass through the process of photosynthesis. Belowground, forest soils have been shown to store a significant amount of carbon in their soil organic matter – up to two times as much carbon as found aboveground.

While forests, both passively and actively managed, function as "sinks" in which to store carbon, they also serve as sources of greenhouse gas emissions including carbon dioxide. Natural biological processes, natural disturbances, and forest management activities (including harvesting and prescribed burning) all result in carbon emissions. Assuming sustainable practices, where trees continue to grow and store carbon on disturbed lands at a greater rate than they decay or are harvested, no net carbon is assumed lost from the forest over the long term. However, unsustainable harvesting, or the conversion of forests to other land uses, can produce net carbon emissions to the atmosphere. Houghton and Hackler (2001) estimate that since 1850, roughly 35% of global anthropogenic $CO_2$ emissions resulted directly from land use impacts.[3]

When forests are converted to residential and commercial development, carbon loss occurs through several mechanisms.

Soil carbon is depleted and released to the atmosphere when:

- topsoil is scraped away to level the construction site or to prepare a driveway or road,
- foundations are dug,
- and soil is disturbed while clearing vegetation (*e.g.*, by skidders).

Aboveground carbon is emitted when trees and stumps are cut down. If the wood is chipped and combusted or left to decay on site it will emit carbon to the atmosphere fairly quickly. If it is converted into durable wood products or ends up in a landfill, the carbon may take several decades before being emitted to the atmosphere.

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[3] R. A. Houghton, J. L. Hackler, 2001. Carbon Flux to the Atmosphere From Land-use Changes: 1850 to 1990. ORNL/CDIAC-131, NDP-050/R1 (Oak Ridge National Laboratory, Oak Ridge, TN.

In paved and landscaped areas, which can make up the majority of smaller lots, these trees will never grow back. By comparison, forested areas will continually remove carbon from the atmosphere and store it in growing biomass.[4]

The carbon impact of converting forests to cropland and pastureland has been well-documented.[5] However, the impact of residential and commercial development, especially on soil carbon, has been less well-studied, and varies widely by the type and location of development. Pouyat et al (2006) found that urban development in the northeast United States resulted in soil carbon losses due to the high initial concentrations of carbon in the native forest soils of the Northeast.[6] By way of illustration, compared to forested soils in the Northeast, the Pouyat study found that soils in Boston, having been fully developed, contained approximately 64% less soil organic carbon.

A study of exurban development since 1970 in Central New Hampshire (Wienert and Hamburg[7]) found that, on average, the development of a housing lot caused the loss of 59 metric tons carbon (Mg C) (or 185.42 Mg $CO_2$) per house. This amount of carbon loss reflects the combination of direct emissions from lot preparation and lost sequestration potential.[8]

The loss of carbon depends on both the current carbon storage per acre on the lot and on the area of the lot that is disturbed through excavation and vegetation removal. There is not a linear relationship between loss of carbon and number of acres in a developed lot. While the average lot size in the Wienert study was 1.74 acres, and the average disturbed area 0.6 acres, plotting lot

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[4] Additional sequestration may begin to plateau when the forest stand reaches about 125 years of age.
[5] For example: Woodbury, Peter B.; Heath, Linda S.; Smith, James E. 2006. Land Use Change Effects on Forest Carbon Cycling Throughout the Southern United States. *Journal of Environmental Quality.* **35**: 1348-1363. Birdsey, R.A. and Heath, L.S. 2001. Forest inventory data, models, and assumptions for monitoring carbon flux. P. 125-135. In: Lal, R., ed. *Soil Carbon Sequestration and the Greenhouse Effect*. SSSA Special publication No. 57. Soil Science Society of America, Inc. Madison, WI. 236.
6 Richard V. Pouyat, Ian D. Yesilonis and David J. Nowak. 2006. Carbon Storage by Urban Soils in the United States. J Environ Qual 35:1566-1575.
[7] Wienert, A. and S. Hamburg. Carbon stock changes and greenhouse gas emissions in from exurban land development in central New Hampshire. Brown University, Center for Environmental Studies. Unpublished thesis.
[8] Initial emissions are higher, but some is re-sequestered over the 50 years analyzed in the study. 10% of the aboveground biomass that is removed is assumed to remain in products, based on land-clearing practices in the region.

size to disturbance area found that a three-fold increase in lot size led to a doubling of disturbance area size. However, variability increased with lot size greater than one hectare (2.47 acres). For example, while the size of the house and lawn might roughly double from a 1-acre lot to a 2-acre lot, the footprint of a house built on a 100-acre lot is not expected to be 100 times bigger.

In order to most accurately estimate the carbon impacts of a development proposal, it is necessary to estimate the square footage of proposed buildings and roads, as well as the proportion of landscaped areas to what remains as forested land.

<u>Estimated Carbon Losses from Converting Forestland</u>

The most recent Plum Creek development proposal envisions a maximum of:

- 975 residential units
- 1050 resort units (from a mixture of single-family units, townhouse and apartment style units)
- 2 resort lodges
- 190 employee housing units
- 100 affordable housing units.[9]

In the following calculation, we assume that the footprint for residential units are roughly equivalent to those in the New Hampshire Study (average 1367 square foot house footprint, with an average lot of 1.74 acres, 0.6 acres of which are disturbed during construction and lot preparation). Furthermore, we assume that the 1050 resort accommodations are 75% detached units, with a footprint of 1000 square feet per unit in Moose Mountain, and 2000 square feet per unit in Lily Bay, and 25 % attached units, with a footprint of 250 square feet per unit in Moose Mountain and 500 square feet per unit in Lily Bay. Details on the layout and size of resort accommodations have not been provided by Plum Creek, so these numbers were used in order to

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[9] Estimated employee and affordable housing units from Colgan, "Estimated Economic Impacts from Development Associated with the Proposed Rezoning of Lands Owned by Plum Creek Timber in the Moosehead Lake Region," May, 2007.

provide some estimated quantification. Affordable housing and employee housing are assumed to convert less land per unit and thus result in half the emissions of a regular residential unit. If affordable housing and employee units and are built as attached units, the emissions per unit may be even lower.

In order to estimate a range of emissions, three methods were used to determine carbon loss per unit of development:

1) the total emissions per house unit from the Wienert and Hamburg study;
2) the percent emissions loss found by Wienert, applied to the carbon in an average 50 year old forest in Maine (based on federal inventory data); and
3) the same method as #2, but assuming the forest has been recently cleared.

In the third case, initial year carbon losses from removal of aboveground biomass are much lower than in the second case, where the forest is older, but lost sequestration potential is roughly equal in both cases. Over a period extending beyond 50 years, lost sequestration potential is actually higher in the young forest because tree growth rates (and thus carbon storage rates) will take longer to plateau.

Land cover maps submitted by Plum Creek show that the lots proposed for development fall into several different forest size classes, from saplings to small sawtimber. Some pockets of mature forests do exist within the development envelope, particularly around Prong Pond, and around Burnham Pond and in the upper elevations of the Big Moose Mountain.

As mentioned above, there may not be a linear relationship between lot size or house footprint and the area of disturbance. However, given a lack of other data, we assumed a linear relationship between (1) building footprint in square feet and (2) Mg C loss, based on the relationship between average house footprint and total Mg C loss found by Wienert. These assumptions were made in order to be able to calculate potential losses from the large number of resort units whose footprint might vary significantly from the average 1367 sq. foot footprint / 1.74 acre lot in the Wienert study.

In all cases, the carbon impact is estimated over 50 years. Most of the emissions will occur initially, during the construction phase of the project. The longer period of the analysis allows for the fact that there will be ongoing lost sequestration potential, as well as the fact that soil and vegetation in the developed area will continue to sequester some carbon.

Based on the above calculations, potential land conversion emissions range from 105,648 Mg C to 136,658 Mg C, (387,378 Mg $CO_2$ to 501,081 Mg $CO_2$) depending on the characteristics of the forest that is being replaced (see Appendix 1). If a significant portion of development occurs on lands that have recently been clearcut, the emissions will be at the lower end of the range.

We have not here estimated emissions from certain non-residential development proposed in the Concept Plan, such as golf courses and other landscaped areas. We would expect the emissions factor for each acre of such areas to be somewhat less than in the areas developed for housing or resort buildings because there would be less soil disturbance associated with digging foundations, grading roads, etc. However, a rough emission factor for such areas could be arrived at using weighted averages from federal forest inventory data which indicate that the direct emissions for the removal of aboveground biomass and soil disturbance on an entire acre of forest converted to non-forest in Maine is 29 Mg C/acre for a recently clearcut forest and 55 Mg C/acre for a 50 year old forest. Lost sequestration would be an additional 25.5 Mg C/acre in either case, giving us an emissions factor for golf courses and other non-housing landscaped areas in the range of 54.5 to 84 Mg C/acre.

Land Conversion Carbon-Saving Modifications

Carbon emissions from forest land conversion can be modified by clustered development. For example, a study done by the NOAA Coastal Service Center, compared the environmental and economic impacts of three development scenarios -- a Conventional Design, a Conservation Design, and a New Urbanist Design -- on a proposed 1,100 acre development by Land Resources Companies.[10]

Land development practices that retain open space and vegetation were found to reduce carbon losses. The clearing cost per acre remained the same, but the total acreage cleared varied from

[10] NOAA Coastal Services Center. Alternatives for Coastal Development: One Site, Three Scenarios, 2004. In Peterson, T. 2004. http://www.csc.noaa.gov/alternatives/

401 acres in the Conventional Design to 165 acres in the New Urbanist Design. The study estimated carbon savings from avoided clearing were estimated to be 53.35 tons of carbon per acre. Changing from the Conventional Design to the New Urbanist Design resulted in a 41% reduction in the area cleared with an only 2% reduction in number of housing units.

In the Plum Creek Project Plan, a 41% reduction in total area cleared for the 975 residential units would result in emissions savings of between 27,957 to 36,126 Mg C (102,510 to 132,461 Mg $CO_2$).

Below are details from the development scenarios used in the NOAA study:

*Conventional Design* - characterized by single-family dwellings with relatively large lots. The road network includes low-traffic cul-de-sacs. Marshfront and waterfront lots are maximized.

- 857 single-family residential units on 815 lots.
- 100 multifamily residential units on 5 lots.
- Total floor area of all residential housing units approximately 2,293,650 square feet.
- Average single family residential lot size is 0.61 acres.
- 85 acres on the site are reserved as open space.
- Ratio of .09 acres of open space per unit

*Conservation Design* - protects contiguous open space by clustering homes on lots that are slightly smaller than conventional lots. This scenario is characterized by distinct neighborhoods of primarily single-family units targeting a range of incomes and surrounded by open space and recreational trails. Conservation measures go beyond those that are required by law, including vegetated buffers and swale drainages along roads.

- 720 single-family residential units on 698 lots.
- 22 estate homes include an additional carriage house on the property.
- Total floor area of all housing units approximately 1,079,750 square feet.
- Average residential lot size is 0.2 acres.
- 469 acres across the site are preserved as open space.
- Ratio of .65 acres of open space per unit.

*New Urbanist Design* - more compact, village-type development, with relatively small lots and an emphasis on public spaces. This scenario is characterized by three distinct villages, connected by roads and trails, and containing a mix of commercial and residential uses. Residential units consist of single- and multifamily dwellings.

- 867 single-family residential units on 867 lots.
- 70 multifamily residential units on 4 lots.
- Total floor area of all residential housing units approximately 1,596,125 square feet.
- Average single-family residential lot size is 0.18 acres.
- 445 acres on the site are reserved as open space.
- Ratio of .47 acres of open space per unit.

## III. Carbon Emissions from Transportation

The proposed Plum Creek development will have carbon dioxide emissions associated with the gasoline and diesel fuel that is combusted in cars and buses carrying guests and employees from their point of origin to the Greenville area and also locally within the area of Greenville and the Concept Plan development.[11]

Based on our current knowledge of the number of proposed resort units and residential development units and approximate distances from those units to both Greenville and to the visitors' points of origin, we have created an illustrative scenario to estimate the CO2 emissions for the travel associated with the Concept Plan.

<u>Estimated Carbon Emissions from Transportation</u>

As with any scenario modeling, the assumptions made will determine the results. If assumptions are changed to lower the number of guests/employees, the number of local visits to Greenville,

[11] We do not here make any assumptions or estimate of the total CO2 emissions (or fine particulates or nitrogen oxides) from the equipment or vehicles engaged in land clearing, excavating, grading, paving or construction.

the number of annual visits from non-resident travelers, or the distances traveled for any of these trips, then the VMT estimates will decrease and so will the $CO_2$ estimates. The assumptions we employed in estimating the VMT and associated $CO_2$ emissions are described below.

For ease of analysis, we assume four categories of trips:

- Resort employee (and employee family member) local trips from Big Moose Mountain and Lily Bay resorts into Greenville
- Guest local trips from Big Moose Mountain and Lily Bay resorts into Greenville
- Guest local trips from the residential development units into Greenville
- Guest point of origin trips from various places to get to the Concept Plan area (e.g., from Bangor, from out of state)

For purposes of illustration of the distances traveled by employees and guests for local trips, ENE assumes the approximate distance from Greenville to the Big Moose resort is 11 miles and from Greenville to the Lily Bay resort is 15 miles. The average distance from Greenville to all residential units is assumed to be 15 miles.

For purposes of illustration of the distances traveled by guests from their point of origin to Greenville, ENE has used rough estimates of the driving distance and the percent of guests traveling from (and home to) those points of origin:

Table 1 – Travel Assumptions for Big Moose Resort Guests

| **Point of Origin** | **Distance to Moosehead Area (miles)** | **Guests From this Point of Origin** |
|---|---|---|
| Bangor | 75 | 20% |
| Portland | 150 | 20% |
| Portsmouth | 205 | 50% |
| Jackman | 65 | 10% |

Table 2 – Travel Assumptions for Lily Bay Resort Guests

| Point of Origin | Distance to Moosehead Area (miles) | Guests From this Point of Origin |
|---|---|---|
| Bangor | 75 | 40% |
| Portland | 150 | 10% |
| Portsmouth | 205 | 40% |
| Jackman | 65 | 10% |

Table 3 – Travel Assumptions for Residential Development Unit Guests/Residents

| Point of Origin | Distance to Moosehead Area (miles) | Guests From this Point of Origin |
|---|---|---|
| Bangor | 75 | 15% |
| Portland | 150 | 30% |
| Portsmouth | 205 | 50% |
| Jackman | 65 | 5% |

ENE made assumptions about the numbers of both point of origin trips and local trips based on how many employees and guests would be at the Plum Creek resorts and residential developments throughout the course of the year, as follows:

- The number of employees is assumed to be 245 for Big Moose resort and 150 for Lily Bay.[12] For each employee (including his or her family), we assumed an average of five round trips from a resort to Greenville per week.
- The number of resort guest visits is arrived at by using annual occupancy rates of 65% as per the Concept Plan analysis.[13] For each resort guest visits, we assumed two round trips from the resort into Greenville per visit.
- For the residential development units, we assume 15% permanent residents and 85% part-time residents.[14] We further assumed permanent residents made 5 visits to Greenville per week per unit, and that part-time residents (and their guests) would make 20 visits per year to the area, and for each visit would make two round-trips to Greenville per unit.

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[12] Plum Creek, Concept Plan, Appendix A-D, April 2007, p. 50.
[13] *Id*., p. 64.
[14] *Id.*, citing Colgan Economic Impact Analysis, 2006

Our illustrative scenario estimate indicates annual vehicle miles traveled (VMT) within Maine at just more than 22 million miles per year and emitting approximately 9,500 metric tons of $CO_2$ per year. This is the equivalent of the annual emissions of about 1,850 cars.

Transportation Carbon Saving Modifications

Modifications to the Concept Plan can reduce the carbon emissions of the development using any of two basic transportation measures:

- reduce VMT;
- employ cleaner energy sources for transportation.

One simple way the Concept Plan can reduce VMT is to design the project in ways that will reduce travel distances within the resorts and residential developments and from them into Greenville. This can be achieved by locating resorts and residences closer to Greenville or other places guests or employees will visit and work, and by clustering development units closer together. Designing the project so that as many trips as possible can be achieved by walking or biking will reduce VMT, as will offering access (through public or private vendors) to transportation modes such as trains, buses, ferries, limosines or taxis, will allow people to avoid using their car for local trips and trips from their points of origin.

Transportation modes can be made cleaner if they are switched to vehicles and vehicle energy supplies (*i.e.*, fuels) that are more efficient and have lower lifecycle carbon emissions than the average car running on gasoline. For example, enhanced use of battery electric vehicles or hybrid electric vehicles will lead to lower carbon emissions per mile traveled. Because electric vehicles are constrained by the distance they can travel on a single charge, initial design of the project will determine the extent to which these vehicles are practical. Additionally, retrofits of diesel particulate filters on heavy duty diesel construction equipment or buses can reduce black carbon emissions (which have a global warming impact about 600 times more potent than $CO_2$) by 90%.

## IV. Carbon Emissions from Building Energy Use

The energy required to heat, cool and provide electricity to the various buildings in the Concept Plan is another significant source of $CO_2$ emissions.

Estimated Carbon Emissions from Building Energy Use

ENE made the following assumptions about the Concept Plan's electricity consumption:

- residential development units consume the same as the average for all Maine households, while discounting this rate by 50% for units occupied by part-time residents;
- the units use electricity with a $CO_2$ emissions profile equal to the average for Maine; and,
- we have no basis for making an assumption on the electricity consumption of the resorts.

We assumed home heating oil would be consumed as follows:

- at the average rate (gallons per square foot) of homes built to Maine Energy Efficiency Building Performance Standards in effect in the year 2000, based on modeled performance of home heating efficiency in 1,920 square foot homes in Caribou, Maine in the R.J Karg Associates Study, and at 50% of that rate for all part-time residents;[15]
- for the Big Moose resort units, 25% would be 1,000 sq. ft. attached units and 75% would be 2,000 sq. ft. detached units;
- for the Lily Bay resort units, 25% would be 2,000 sq. ft. attached units and 75% would be 4,000 sq. ft. detached units;
- that all units in the residential development would be equal in size to the homes modeled in the Karg Associates study (*i.e.*, approximately 2000 sq. ft.).

[15] R.J. Karg Associates, Economic Analysis for Maine Residential Energy Standard, 2002

It is useful to make several notes about building efficiency standards. First, there is no mandatory minimum energy efficiency standard for residential houses in the LURC jurisdiction in which the Concept Plan is proposed. Second, the year 2000 standards modeled in the Karg study are not very efficient. That same study also modeled a 30% efficiency improvement assuming buildings were constructed to meet the Residential Energy Standard (RES) that was then under consideration in the Maine legislature and which was later adopted with some modification as the state's model code. We use the RES modeled results as a suitable proxy for the efficiency levels in current model building energy code applicable in participating jurisdictions in Maine. Finally, we note that numerous studies by the U.S. Department of Energy indicate that building energy efficiency can be cost-effectively improved by as much as 50% in new construction situations.

ENE estimates that the residential development units alone would consume approximately 5.29 million kWh of electricity each year. The residential development units plus the resort units are projected to consume nearly 1.2 million gallons of home heating oil as well. Together, these energy supplies would account for at least 13,018 metric tons of $CO_2$ per year.

Building Energy Carbon Saving Modifications

The most effective way the Plum Creek project can reduce carbon emissions associated with building energy is by maximizing the energy efficiency of all structures that require heating, cooling and lighting.

As a starting point, we note that the use of best practices in the design and construction of buildings has the potential to cost-effectively reduce energy consumption (and associated $CO_2$ emissions) by 50% from the conventional construction efficiency levels.

The following Table illustrates the potential energy and carbon savings if the project developers were to employ either of two alternatives to the basic construction standards in use in 2000.

Table 4 – Comparison of heating oil consumption and associated CO2 emissions

| **Heating Oil Consumption and Associated CO2 Emissions** | **Assuming Maine Building Performance Standard (BPS) (2000)** | | **Assuming Maine Residential Energy Standard (RES) (2003) + Lodges 50% Better than Avg.** | | **Assuming Residential Units 50% Better than BPS + Lodges 50% Better than Avg.** | |
|---|---|---|---|---|---|---|
| | *gal/yr* | *tons CO2/yr* | *gal/yr* | *tons CO2/yr* | *gal/yr* | *tons CO2/yr* |
| Big Moose | 523,600 | 5,315 | 357,300 | 3,627 | 261,800 | 2,658 |
| Lily Pond | 284,063 | 2,884 | 200,313 | 2,033 | 142,031 | 1,442 |
| Residential Units | 354,876 | 3,603 | 239,387 | 2,430 | 177,438 | 1,801 |
| **TOTAL** | 1,162,538 | 11,801 | 796,999 | 8,091 | 581,269 | 5,901 |

Another way the project can reduce its building energy CO2 emissions is by procuring cleaner energy supplies. For example, the resort owner/operators could enter bilateral contracts for cleaner electricity supplies. They could also self-generate power (and in some cases heat) through the use of clean distributed generation supplies that are cleaner than the available grid power. Types of distributed generation that may be appropriate for the project area include photovoltaics, solar thermal, geothermal, small wind, and gas-fired combined heat and power systems.

## V. Summary

Based on our review of the record and the assumptions and approach described above, we estimate that carbon impact of the Concept Plan may be summarized as follows:

- Forest Land Conversion -- between 387,378 and 501,081metric tons $CO_2$ from forest land conversion, of which roughly half is emitted to the atmosphere immediately (during development) and the other half is lost carbon storage potential <u>over a 50 year period</u>;
- Transportation -- emissions of approximately 9,566 metric tons CO2 <u>each year</u>;
- Building energy -- emissions of at least 13,018 metric tons CO2 <u>each year</u>.

Thoughtful employment of carbon mitigation measures could reduce these emissions and help achieve the state Climate Action Plan as well as the Regional Greenhouse Gas Initiative and other state and regional policy objectives.

We cite an example where improved development designs were modeled to shrink the amount of forest land conversion and soil disturbance and thus achieve a 41% reduction in total land area cleared compared to a conventional development design. We estimate that if such a reduction were applied to the Concept Plan's residential development units alone it would deliver CO2 savings of between 102,510 to 132,461 metric tons.

We have not attempted to estimate the project's potential to reduce transportation emissions using mitigation measures.

We also note that the use of advanced building design can cost-effectively improve the energy efficiency of newly constructed buildings by as much as 50%. Such an improvement in the energy efficiency of new buildings in the Concept Plan could deliver dramatic cost savings to the buildng owner/operators and also reduce CO2 emissions from oil heating by nearly 6,000 metric tons each year.

Environment Northeast

## APPENDIX 1

### Metric Tons Carbon Loss from Residential and Resort Development

| in Moosehead Lake RegionUnits | NH Emissions Factor | | Using NH% carbon loss, assuming 50 yr. old ME forest | | Using NH% carbon loss, assuming 0 yr. old ME forest | |
|---|---|---|---|---|---|---|
| | *Per Unit (Mg C)* | *Total (Mg C)* | *Per Unit* | *Total* | *Per Unit* | *Total* |
| 975 residential | 59 | 57525 | 63 | 61230 | 49 | 47385 |
| 600 detached resort, Big Moose | 43 | 35400 | 63 | 37,680 | 49 | 29160 |
| 188 detached resort, Lily Bay | 86 | 15980 | 92 | 17,009 | 71 | 13163 |
| 100 affordable housing | 30 | 3000 | 32 | 3,150 | 24 | 2400 |
| 190 employee housing | 30 | 5700 | 32 | 5985 | 24 | 4560 |
| 200 attached resort, BM | 11 | 2200 | 11 | 2342 | 9 | 1812 |
| 62 attached resort, LB | 22 | 1364 | 23 | 1452 | 18 | 1124 |
| Lodge BM | 3,669 | 3,669 | 3905 | 3905 | 3022 | 3022 |
| Lodge LB | 3,669 | 3,669 | 3905 | 3905 | 3022 | 3022 |
| **Total Mg C** | | **128,507** | | **136,658** | | **105,648** |

Note: Totals may not add up due to rounding.