

Ontario

ecological  
**LITERACY**

GUIDE



# CLIMATE CHANGE

IN GRADE 10 SCIENCE  
(APPLIED)



**ecoschools**

### **Acknowledgements**

The Government of Canada's Climate Change Action Fund provided major funding for Ontario EcoSchools. Please see back cover for more information on all of the partners involved in the development of the program.

*Ontario EcoSchools: Climate Change in Grade 10 Science (Applied)*

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**Designer:** Comet art + design

# Science and EcoSchools

*Climate Change in Grade 10 Science* is one in the series of Ecological Literacy guides that make up the classroom component of EcoSchools. These guides offer teachers a new lens for seeing the environmental learning possibilities in the Ontario curriculum.

This resource is supported by *The Science of Climate Change*, a multimedia presentation that has been developed specifically to complement the Grade 10 Science curriculum. The multimedia presentation is available on CD; please see [www.yorku.ca/fes/envedu/ecoschools.asp](http://www.yorku.ca/fes/envedu/ecoschools.asp) for ordering information.

Included in this resource are Big Ideas about climate change, Focus Questions, a choice of two culminating tasks and an annotated bibliography. Together, these materials provide a wealth of ideas that teachers can draw on in all areas of their program. These resources foster an approach that links knowledge to choices that lead to a more sustainable way of life.

Ontario EcoSchools Science resources have been developed to improve science and ecological literacy about one of the most important global issues facing us. These resources strive to educate students so that they will understand the science of climate change. This knowledge will be essential so that, as citizens, they can be part of the debate as government and industry respond to the challenges and opportunities that a changing climate will bring.

# GUIDES FOR GETTING STARTED

## 1 *Introduction to EcoSchools and the Five-Step Process*

This concise guide provides an overview of the Ontario EcoSchools program and sets out a practical method for successful implementation: (1) establish an EcoTeam, (2) assess the school's needs, (3) identify priorities and develop an action plan, (4) implement the action plan, and (5) monitor and evaluate progress.

## 2 *Waste Minimization Guide*

This guide outlines the 10 Ontario EcoSchools waste minimization guidelines. It provides the school's EcoTeam with tips for assessing the school's current waste minimization efforts, sample reviews and action plans and a set of tools for implementing improved waste minimization practices.

## 3 *Energy Conservation Guide*

Similar in format to the *Waste Minimization Guide*, this resource outlines the 10 Ontario EcoSchools energy conservation guidelines. It provides the school's EcoTeam with tips for assessing the school's current energy conservation efforts, sample reviews and action plans and a set of tools for implementing improved energy conservation practices.

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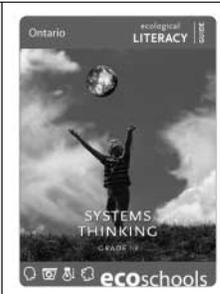
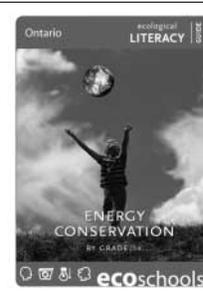
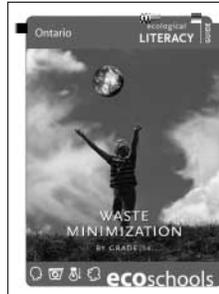
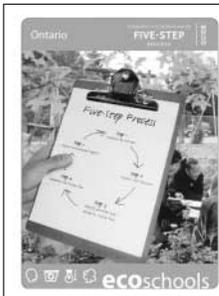
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## 4 *Waste Minimization by Grade (1-8)*

This resource is organized around “big ideas” about waste and waste minimization that are based on identified clusters of learning expectations in both Science and Technology and Social Studies and Geography. Using these ideas as a focus helps the teacher incorporate ecological thinking into existing curriculum. Annotated Internet resources offer background facts and student learning activities.

## 5 *Energy Conservation by Grade (1-8)*

Like *Waste Minimization by Grade*, this guide is organized around “big ideas” about energy and energy conservation that are based on identified clusters of learning expectations in both Science and Technology and Social Studies and Geography. Using these ideas as a focus helps the teacher incorporate ecological thinking into existing curriculum. Annotated Internet resources offer background facts and student learning activities.

## 6 *Systems Thinking: Grades 1-8*

This resource helps shift our view of the nature of the human and natural worlds: instead of being collections of separate parts, they are seen as whole systems greater than the sum of their *interdependent* parts. Seeing the curriculum through a Systems Thinking lens highlights how the *interconnections* among learning expectations bestow the power of describing how the world works – seeing people in relation to the environment. This approach integrates diverse learning expectations into coherent clusters. Available in 2005.

CONNECTING ECOSCHOOLS  
TO THE ELEMENTARY CURRICULUM

# CONNECTING ECOSCHOOLS TO THE SECONDARY CURRICULUM

## 7 *Climate Change in Grade 9 Geography (Academic and Applied)*

This resource consists of a culminating task for summative evaluation plus a unit-by-unit breakdown of the conceptual understandings about climate change needed to ensure student success. Students select a Canadian town or small city and develop an annotated map that indicates the changes in the human and natural environments that would reduce greenhouse gases and thus slow climate change. Resource list, student worksheets and evaluation rubric are provided. See #17 for supporting multimedia presentations.

## 8 *Climate Change in Grade 10 Civics*

This unit introduces students to the concept of citizenship through a series of well-supported activities where they analyze the accomplishments of environmental activists and organizations. A simple Public Policy Primer helps students see points at which they can influence issues. Students apply their knowledge in responding to the Government of Canada's One-Tonne Challenge for reducing climate change gases. An Environmental Citizenship Portfolio containing each student's class work and other materials sums up her/his understanding of environmental citizenship. See #17 for supporting multimedia presentations.

## 9 *Climate Change in Grade 10 Science (Academic and Applied)*

This resource provides two possible culminating tasks: students are introduced to an actual problem and asked to propose solutions to either The Impact of Transportation Choices or Forest Management and Climate Change. Climate change related concepts have been identified in each strand. Charts link authorized texts and the Teacher Resource for each to relevant learning expectations. A student Checklist of Preparation, annotated Internet resources and evaluation rubrics are also provided. See #17 for supporting multimedia presentations.

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## 10 *Climate Change in Grade 11 and 12 Science*

This resource ranges over 8 different Science courses (University, University/College, College and Workplace), highlighting learning expectations that can be met using climate change issues as the examples. Focus questions help students connect the learning of facts and concepts in a meaningful way. The questions also suggest ways to adapt the existing curriculum to explore the data, evidence, interactions and technologies related to climate change issues. Lists of resources that suit the needs of the courses are included. See #17 for supporting multimedia presentations.

## 11 *Climate Change in Grade 11 and 12 Geography*

This resource surveys 5 Geography courses (University, University/College, and Open). Overall and specific expectations for each course are accompanied by guiding ideas linking these expectations to different parts of the climate change story. Examples are provided for developing topics, and teaching and learning strategies recommended for different student needs. Resources for planning class activities and assignments are listed. See #17 for supporting multimedia presentations.

## 12 *Interdisciplinary Studies: Climate Change and Your Future - Grade 12 (Open)*

This single-credit course reviews the impacts of climate change on human and natural systems. Students investigate local businesses and agencies to learn about environmental practices that reduce the impact of climate change. Through case studies, students identify emerging work opportunities; in the culminating task students develop a business plan related to mitigating or adapting to climate change. See #17 for supporting multimedia presentations. Available in 2005.

## GUIDES TO ENRICH YOUR PROGRAM

### 13 *Schoolground Greening: Designing for Shade and Energy Conservation*

Based on a guide developed by Evergreen and the Toronto District School Board, this resource will help schools design for increased shade to protect students and staff from ultraviolet radiation (UVR) and to shade school buildings to save energy and make them more comfortable. Tips for involving the school community in the design process, surveying user needs, completing a site analysis, creating site plans and developing a fundraising strategy are included.

### 14 *Celebrating EcoSchools: Festival Guide (Elementary)*

This collection of learning activities for elementary schools is designed for Earth Week or another EcoSchools celebration. While each activity can stand alone, the collection is especially designed for an entire school to engage in environmental learning adventures, focussing on the theme of human-environment connections. Based on a resource developed by the City of Toronto and the Toronto District School Board.

### 15 *The 20/20 Planner*

Based on a Toronto Public Health resource, *20/20 The Way to Clean Air* offers teachers a way to help students apply their learning about energy conservation at home. The planner is a “take-home” guide filled with simple tips and activity sheets that offer a range of actions that students and their families can undertake to reduce energy and vehicle use by 20% and respond to the Government of Canada’s One-Tonne Challenge.

### 16 *Certification Guide*

The *Certification Guide* is based on a resource developed by the Clean Air Partnership and the Toronto District School Board. It provides sample benchmarks and a scoring system for schools wishing to assess their environmental performance in a limited number of areas. The point system establishes Bronze, Silver and Gold levels of EcoSchools. How participating schools are recognized is left to individual Boards to decide.

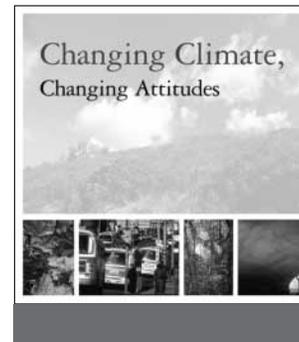
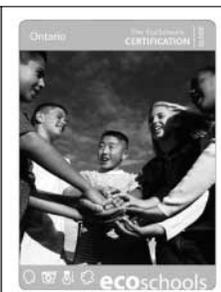
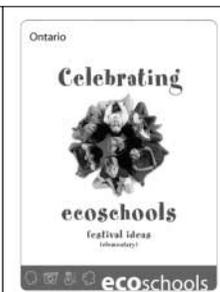
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Free copies of all Ontario EcoSchools guides may be downloaded in PDF format. Go to [www.yorku.ca/fes/envedu/ecoschools.asp](http://www.yorku.ca/fes/envedu/ecoschools.asp)

The three multimedia presentations are available only on the *EcoSchools Resources for Ontario Schools* CD (both PC and Mac-compatible). This CD also includes the Ontario EcoSchools guides and curriculum resources and is available for the cost of shipping and handling. For ordering information, please contact:

Library and Learning Resources  
Toronto District School Board  
Tel: 416-397-2595 Fax: 416-395-8357  
Email: [curriculumdocs@tdsb.on.ca](mailto:curriculumdocs@tdsb.on.ca)

### 17 **Multimedia presentations:** *Changing Climate, Changing Attitudes; The Impacts of Climate Change; The Science of Climate Change*

Three multimedia presentations have been designed to accompany the EcoSchools curriculum resources. *Changing Climate, Changing Attitudes* provides students and teachers with a general overview of global climate change and its impacts on Ontario society. *The Impacts of Climate Change* has been developed explicitly to complement the Grade 9 Geography course but can be used with all secondary students to examine the impacts of climate change on the natural and human worlds. *The Science of Climate Change*, while developed to support the Grade 10 Science course, is suitable for all secondary science students. These presentations include potential solutions and steps that citizens can take to help slow climate change.

## MULTIMEDIA PRESENTATIONS TO ANCHOR YOUR PROGRAM

# ecological LITERACY

## GUIDE

### Climate Change in Grade 10 Science (Applied)

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Ecological *inquiry* reveals our dependence on the healthy functioning of the earth's living systems which give us clean air, water, soil, food, and all the other resources we depend on. As our understanding of the inter-relatedness of all life increases, we can become literate in the ways to care for the earth that consider the wellbeing of future generations. Ecological *literacy* allows us to understand the urgency of developing protective, sustainable, and restorative relationships with the natural systems that are affected by our daily activities.

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## ▶ CLIMATE CHANGE AND GRADE 10 SCIENCE (APPLIED)

Several of the main concepts of Grade 10 Science (Applied) can be linked to understanding the phenomenon of climate change. Through science we understand how greenhouse gases are formed and how they contribute to changing levels of carbon dioxide in the atmosphere. As students explore the chemical reactions that contribute to climate change, they identify the factors that disrupt ecological balances within local and global ecosystems. Atmospheric carbon changes the way energy is retained on Earth, changing the motion of global wind and ocean current patterns.

In this resource, students use science to assess the environmental impact of either urban sprawl or contemporary logging practices. The purpose of each culminating task is to have students suggest alternatives that will mitigate greenhouse gas emissions.

### ▶ Resource Overview

This resource outlines how a series of Big Ideas about climate change can illuminate some of the main concepts in Grade 10 Science. Two culminating tasks are provided: *Urban Sprawl and the Environmental Impact of Transportation Choices* and *Forestry Management and Climate Change*. These tasks give students an opportunity to integrate their learning and apply their knowledge to situations where they are asked to explore ways to reduce greenhouse gas emissions.

#### **This resource includes:**

- ▶ **Big Ideas** about concepts that underlie the science of climate change;
- ▶ **Prior learning** – both fundamental skills and science background – required to complete the tasks;
- ▶ **Focus Questions** related to the Big Ideas in each of the strands which suggest ways to organize ideas as you plan your lessons with the culminating task in mind;
- ▶ **Culminating tasks** to help students explore how our individual and collective actions affect the earth's ecosystems and climate;
- ▶ A chart that shows how approved **textbooks and blackline masters** support learning about climate change;
- ▶ An **annotated list of websites** that accompanies each task.

## ► UNDERSTANDING CLIMATE CHANGE: BIG IDEAS

The big ideas identify some of the concepts underlying climate change science and create a context for the culminating tasks:

- ▶ the flow of energy on the planet;
- ▶ the role carbon compounds play in changing the flow of energy;
- ▶ the choices that we can make to reduce the impact of carbon compounds on the flow of energy.

To understand these big ideas, several concepts are used to illustrate processes on Earth:

- ▶ the global carbon budget;
- ▶ the global radiation balance;
- ▶ “green” technologies that reduce CO<sub>2</sub> emissions.

The carbon budget consists of *sources* of gaseous carbon emissions and *sinks* where carbon is sequestered from the atmosphere. Within a natural ecosystem, there are many sources and sinks. Some human activities (e.g., fossil fuel based industries, transportation) are sources of carbon emissions while others (e.g., logging, filling in wetlands) destroy or impair the action of carbon sinks.

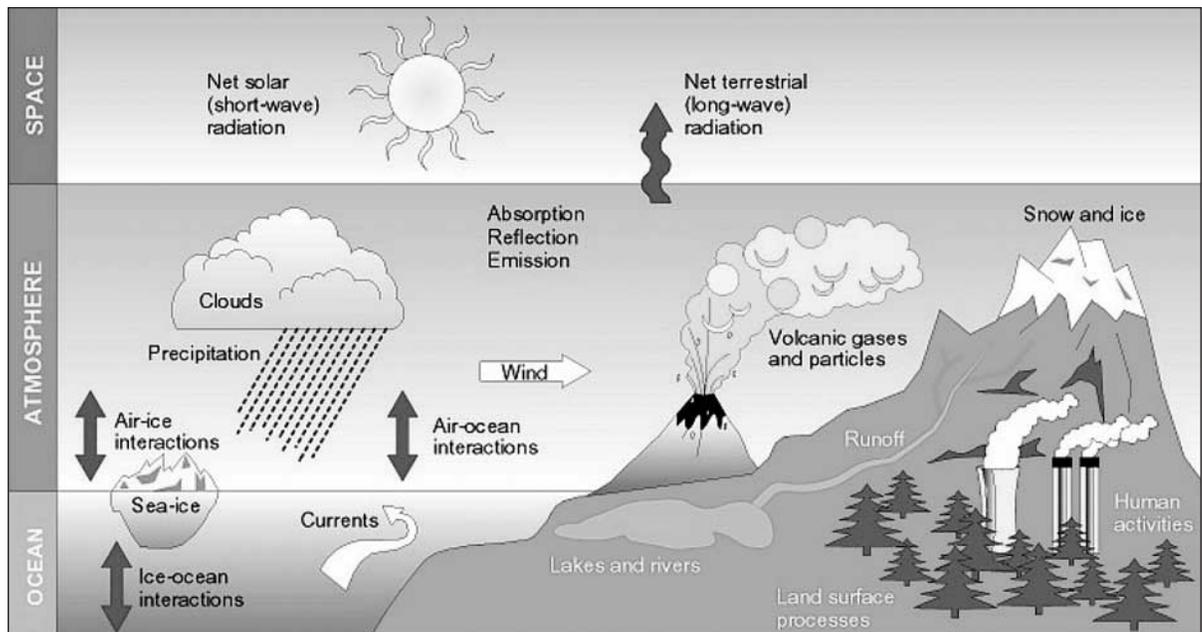
Energy from the sun drives Earth’s weather and climate. This energy eventually leaves the Earth as heat. Certain atmospheric compounds, such as CO<sub>2</sub>, absorb this energy and retain it in the atmosphere. This creates an imbalance, where less energy is released from the Earth than absorbed. New solar radiation continues to arrive on Earth, and the resulting energy imbalance affects global climate patterns.

Connecting CO<sub>2</sub> production to energy flow in the atmosphere and hydrosphere provides students with an understanding of how small changes in the concentration of CO<sub>2</sub> in the atmosphere can have significant consequences. Although weather variation is common in a local area, climate change creates greater potential risks. Climate change can have long-lasting effects on different economic sectors, such as forestry, tourism and agriculture.

Throughout this course, *CO<sub>2</sub> production is linked to changes in energy flow within the planet and the choices we make as individuals and as nations.* Heat transfer that affects the patterns of trade winds and ocean currents can lead to extreme changes in climate on the planet.

All of the big ideas presented link to choices. Choice and action help make the concept of climate change more relevant and meaningful to the adolescent student. In the culminating task, the students use research and analysis to apply what they have learned in the course to a plan of action in a specific context.

## ► UNDERSTANDING THE CLIMATE SYSTEM



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### Global Warming or Climate Change?

The terms global warming and climate change are often used interchangeably. What's the difference? Scientists' initial focus on the changing climate was the persistent temperature rise over several decades: hence "warming" was the feature that received major attention. The more comprehensive term "climate change" is more common now; it includes the global warming trend, but also refers to other climate change linked phenomena such as severe weather, melting polar ice caps, and high winds.

A special multimedia resource, *The Science of Climate Change*, has been developed specifically to complement the Grade 10 Science course.

For ordering information, see the back cover of this resource.

## ► CULMINATING TASKS

Two culminating tasks are outlined in the pages that follow; each is designed to be part of the 30% summative evaluation. Students will need 10 to 15 hours to complete the assigned task. Although no specific weight is attached to either task, the suggested value of this task is 10% of the final grade. Expectations from all four strands are included, but not equally distributed.

According to the practice at your school, distribute the Checklist of Preparation (Appendix 1.1 or 2.1) at or near the beginning of the course or toward its conclusion. If you do not distribute the task itself early in the course, you may want to describe in general terms what the final assignment will be. As students work through the course of study, remind them to use the Checklist periodically to track the key ideas and skills they are acquiring in readiness for the culminating task. Where possible, provide students with assessment opportunities to practice the skills needed, such as completing a report, assessing costs and benefits and proposing courses of action for change.

Focus Questions for each strand have been written to suggest ways to organize ideas and lessons to support the culminating task.

# Task 1. Urban Sprawl and the Environmental Impact of Transportation Choices

**Background:** The Greater Toronto Area (GTA) has gone through rapid growth, with urban areas growing into areas that had been rural. People that move to these new suburban areas tend to rely on cars for travel. The increase in car traffic requires more roadways and other support structures, such as gas stations. Rapid public transit could reduce the volume of car traffic, but people require reliable service.

Long-time residents of these small towns and rural areas are concerned that various ecosystems are at risk with increased car traffic and building projects. Others focus on how more cars in the area mean more greenhouse gas emissions. They believe that better town planning and transportation planning will mean that fewer cars are needed. Some people want all future development stopped. The provincial government at Queen's Park is reviewing these concerns.

## Resources:

Several student worksheets/ resources support the task:

- ▶ Appendix 1.1 *Checklist of Preparation - Urban Sprawl and the Environmental Impact of Transportation Choices* helps the student keep track of the information and skills they need to prepare for the assignment.
- ▶ Appendix 1.2 *Summary of the Kyoto Protocol* provides an overview of the Protocol and its goals.
- ▶ Appendix 1.3 *Student Task and Expectations: Urban Sprawl and the Environmental Impact of Transportation Choices* outlines the task and identifies the expectations covered.
- ▶ Appendix 1.4 *Environmental Assessment* and Appendix 1.5 *Cost-Benefit Analysis Form* organize the students' work to help ensure that they have all the information necessary to complete the task.

**Scenario:** Plans for a new suburb to be built next to the town of Mediumville are awaiting final government approvals. It is located 100 kilometres outside of Toronto, and will provide housing for people who work in the city but cannot afford homes there. This new suburb will be built on land that is currently a large farm. It has a wetland and a small forest between the planned subdivision and Toronto. No thought has been given to any kind of organized public transit strategy, either within the suburb, or between it and Toronto. Students are asked to identify a public transit strategy for this planned new suburb, in the hopes of addressing some of the current residents' concerns about its impact on the surrounding environment.

**Student Task:** Students will prepare two reports that outline their findings about the environmental impacts, and write a letter to their local MPP. In this letter, they will suggest a plan of action that helps to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Teacher resources have been developed:

- ▶ Strand-by-strand Focus Questions are supplied to help organize ideas and lessons to support the task.
- ▶ Appendix 1.6 *Environmental Impact—sample answers* has been included to provide a sample of completed worksheets.
- ▶ Appendix 1.7 *Cost-Benefit Analysis Report—sample answers*
- ▶ Appendix 1.8 *Sample Letter to MPP*
- ▶ Appendix 1.9 *Evaluation Rubric for Environmental Assessment*
- ▶ Appendix 1.10 *Evaluation Rubric for Cost-Benefit Analysis*
- ▶ Appendix 1.11 *Evaluation Rubric for Letter to MPP*

## Expectations

[Note: examples in square brackets are additions tailored for this resource.]

		CH1.08P	name and write the formulae for common ionic and molecular compounds
BY1.06P	describe how different ecosystems respond differently to short-term stresses and long-term changes	CH3.01P	use scientific nomenclature to identify common consumer products
BY2.01P	through investigations and applications of basic concepts, identify a current local concern or issue involving an ecosystem [e.g. the impact of building roads and houses in areas that were fields and forests]	CH3.03P	relate chemical reactions (including rates of reactions) to familiar processes encountered in everyday life [e.g., greenhouse gases]
BY2.04P	through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen	ES3.01P	identify the impact of climate change on economic, social, and environmental conditions
BY3.01P	assess the impact of technological change on an ecosystem	PH3.01P	perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
BY3.03P	identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g. the Kyoto Protocol]	PH3.02P	investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Prior Learning Required for this Task

*The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 for a one-page student summary of the Kyoto Protocol.*

*The Ontario EcoSchools multimedia presentation The Science of Climate Change has been designed specifically for Grade 10 Science (see back cover for ordering information).*

### Fundamental Skills

#### ▸ *Read and Analyse*

Students need to be able to read material and identify/classify key ideas:

**Problem**

**Processes**

**Factors**

**Effects**

**Costs**

**Benefits**

Concept mapping activities or using other graphic organizers that help students find and classify information would provide practice.

#### ▸ *Research*

Students need to be able to find information on changing ecosystems. This may include comparing biodiversity at different locations of the school grounds or neighbourhood. Activities that support this require students to find and interpret data. *As students learn about ecosystems in the Biology strand, they should work with the same text and electronic resources that will be available for the summative task.*

#### ▸ *Risk Analysis*

Students need to be able to identify and assess the costs and benefits of various activities or choices. What is the environmental impact of drinks packaged in recyclable containers compared to non-recyclable containers? In particular, students need to assess the environmental impact of various transportation choices, such as public transit vs. bicycles as a way to get to school.

## Science Background

See “How Approved Textbooks Link to Learning about Climate Change” (pages 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

▶ ***Biology: Ecosystems and Human Activity***

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to consider how specific elements in a specific ecosystem respond to short-term and long-term stress. For example, how does a two-lane road affect organisms on either side? How does a divided highway affect those organisms?

▶ ***Chemistry: Chemical Reactions and their Practical Applications***

Vehicular exhaust is a source of greenhouse gases (GHGs). A number of these gases (but not CO<sub>2</sub>) are measured as part of the Drive Clean Program. You may want to have students compare how different gases act differently in the atmosphere.

▶ ***Earth and Space Science: Weather Systems***

This strand gives students ample opportunity to learn and explain how the atmosphere is linked to the flow of energy on Earth. Looking at Canadian climate change sites, students can explore the current state of change and predictions for the future. Special consideration of Ontario would help prepare them for the summative task.

▶ ***Physics: Motion and Its Applications***

Students must have some experience analyzing data for different modes of transportation. Many factors can be considered, such as price, personal choice, existing infrastructures and environmental impact. Ideally, students will have begun to think in terms of the cost and benefits of different transportation systems such as bikes, cars, diesel trucks and trains.

## Focus Questions – Connections to Climate Change

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

### Biology: EcoSystems and Human Activity

#### Focus Questions

- How is the carbon cycle related to climate change?
- What are the consequences of changing the carbon balance?
- How does the production of CO<sub>2</sub> affect the carbon cycle?
- How does CO<sub>2</sub> change the amount of heat in the atmosphere?
- How much CO<sub>2</sub> makes a difference?
- What are the consequences of CO<sub>2</sub> changes on ecosystems?
- How can production of CO<sub>2</sub> be measured?
- What new technologies can monitor and reduce carbon production?
- What kinds of transportation would help meet the targets of the Kyoto Protocol?
- How do governments in Canada support sustainable practices?

#### Climate Change Connections

- ▶ Any model of the carbon cycle for an ecosystem can act as a model for a *carbon budget* for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) by identifying *sources* that emit carbon into the atmosphere and *sinks* that remove carbon from the atmosphere. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- ▶ Heat is an important abiotic factor that helps make the connection between the details of a specific ecosystem and the global context. Increased energy in the atmosphere affects both wind and water currents, affecting weather and climate patterns.
- ▶ Canadian initiatives include technology development, especially the development of “green” technology that has a small ecological footprint, and a system of national parks that protect ecosystems.
- ▶ Explicitly consider the Kyoto Protocol in terms of technology use and development.
- ▶ Clean emissions testing monitors the production of various waste materials from vehicles, including carbon monoxide, but not carbon dioxide.
- ▶ Government policy and support for “green” technology can be explored and assessed.
- ▶ The belief in the need for sustainable activity underlies some policy choices and technological innovation. As more people are affected by the consequences of change, they begin to understand the need for sustainable practices.

## Chemistry: Chemical Reactions and Their Practical Applications

### Focus Questions

What are some of the chemical products of vehicle emissions?

How can the products of one chemical reaction affect the reactions of other substances in the environment?

What are some of the greenhouse gases (GHGs)?

How do GHGs affect the environment?

How do we assess the environmental impact of a chemical process?

How is the chemical nature of the atmosphere changed with the addition of some of the wastes of human processes?

### Climate Change Connections

- ▶ Many industrial and technological processes have a chemical impact on the environment. Reactions of interest should include combustion of carbon compounds to form greenhouse gases, and the products of oxidized metal, which can result from increased air pollution.
- ▶ Products formed by the combustion of organic compounds such as oil, wood or natural gas are released into the environment.
- ▶ Simple chemical equations help explain the processes that form various greenhouse gases.
- ▶ The concentration of greenhouse gases changes the impact of these gases on ecosystems and global climate patterns.
- ▶ Use specific greenhouse gases (including carbon monoxide) and other carbon compounds to reinforce students' understanding of the components of the carbon cycle.
- ▶ Carbon dioxide is the product of many reactions. Identify technology that exists that measures the concentration of carbon dioxide, carbon monoxide and other greenhouse gases. (Ontario's Drive Clean program presents an example of how monitored emissions are used to help track the impact of vehicles on the environment.)
- ▶ Different "green" products or choices can be explored. Sometimes products are "green" because an output (water bottle) is added to a new system that cycles the matter (as fleece clothing). Other products are "green" because they are produced through efficient energy use.

## Earth and Space Science: Weather Systems

### Focus Questions

What is the global radiation balance?

How does CO<sub>2</sub> concentration in the atmosphere affect the global radiation balance?

What is the flow of energy in the atmosphere and hydrosphere?

How does human activity affect the global radiation balance?

How do changes to the global radiation balance affect us?

What are the potential consequences for climate change?

## Climate Change Connections

- ▶ Explain the global radiation balance in terms of energy arriving from the sun and energy leaving the planet to outer space. Then consider how changes to the atmosphere caused by greenhouse gases affect this balance of incoming and outgoing energy. The greenhouse gases absorb outgoing radiation, so less energy leaves the Earth. The solar radiation arriving is almost constant, so the imbalance increases and high levels of energy are retained.
- ▶ With a net change that results in more energy in the atmosphere, the transfer of energy changes affects both trade wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- ▶ Heat transfer is studied in terms of changes in the hydrosphere. This is where heat transfer takes place and where the consequences develop.
- ▶ Consider the consequences of shifting wind patterns and ocean current patterns. This is like climate modeling, and allows students to consider possible future scenarios.

## Physics: Motion and Its Applications

### Focus Questions

How can transportation systems be defined?

What are the costs and benefits of different transportation systems [in terms of energy use or in terms of CO<sub>2</sub> production]?

What is the environmental impact of different transportation systems?

Why are some transportation systems preferred over other systems?

How do the choices relate to individual needs, various commercial interests and flexible transportation options?

### Climate Change Connections

- ▶ Transportation systems can be defined and compared in terms of energy use and CO<sub>2</sub> production.
- ▶ Compare these systems' energy use or CO<sub>2</sub> production to assess the environmental cost of transporting a number of people from one place to another. An example could be a measure of CO<sub>2</sub> production by different students as they travel to school (by bus, car, bike, walk, other).

## Resources

### Textbooks

See “How Approved Textbooks Link to Learning about Climate Change” (page 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

### Websites

#### *Carbon budget*

<http://www.climatechangesolutions.com/science/greenhouse/budget.shtml?o=gases&r=budget>

Simple explanation of model with sample values.

<http://geochange.er.usgs.gov/pub/carbon/fs97137/>

This is a very helpful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

#### *Ecosystems*

[http://www.ec.gc.ca/ecos\\_e.html](http://www.ec.gc.ca/ecos_e.html)

This site from Environment Canada has information about ecosystems across Canada, and in the Great Lakes region.

<http://www.climatehotmap.org/impacts/greatlakes.html>

This is an American site that looks at how human activity has compromised, and continues to compromise, the Great Lakes region.

<http://www.ucsusa.org/greatlakes/>

This excellent site from the Union of Concerned Scientists has links to many PDF files. The focus is to link climate change to ecosystems in the area with an overall view of climate models, extreme weather and actions we can choose.

<http://www.epa.gov/glnpo/ecopage/>

This site has many links that are useful for ecosystem studies.

#### *Vehicle Exhaust*

[http://www.lungusa.org/air/airout00\\_diesel.html](http://www.lungusa.org/air/airout00_diesel.html)

This site is simple and points out that diesel exhaust includes many different compounds that affect human health.

<http://www.osha.gov/SLTC/dieselexhaust/chemical.html>

A good list that includes many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

[http://www.planetdrum.org/guard\\_fox\\_watch.htm](http://www.planetdrum.org/guard_fox_watch.htm)

A site devoted to finding sustainable solutions by developing bioregional activities. This page looks at the environmental impact of transportation routes and vehicular traffic in an environmentally sensitive area (The Winter Olympics in Nagano).

<http://www.nutramed.com/environment/carschemicals.htm>

There are many links on this site. This site identifies health risks from exhaust chemicals.

<http://www.nrdc.org/air/transportation/ebd/chap2.asp>

Good site with health risks outlined and specific chemical products listed.

### *Weather*

[http://www.ec.gc.ca/TKEI/cc\\_weather/s\\_weather\\_e.cfm](http://www.ec.gc.ca/TKEI/cc_weather/s_weather_e.cfm)

This site explains what is meant by “severe weather” and uses Canadian examples as illustrations.

<http://www.epa.gov/glnpo/atlas/glat-ch2.html>

Some basic information about climate in the Great Lakes region.

<http://www.ucsusa.org/greatlakes/pdf/temperature.pdf>

More detailed look at the impact of climate change on the Great Lakes region.

<http://www.great-lakes.net/envt/refs/weather.html>

A site that provides weather information for local areas.

### *Transportation*

<http://www.vtpi.org/tca/tca0514.pdf>

Chapter 14 of the Victoria Transport Policy Institute’s *Transportation Costs and Benefits Analysis* guide focuses on “Land Use Impacts.” It provides a comprehensive and detailed account that may be helpful background information for the teacher wanting to have a more detailed understanding of the connections between urban sprawl and transportation modes.

In particular, the “Environmental Degradation” section (pages 5 - 8) in this chapter bears very directly on the culminating task outlined above.

<http://www.niwa.cri.nz/ncces/co2calc/>

This New Zealand Residential CO<sub>2</sub> Calculator site allows students to calculate the amount of CO<sub>2</sub> produced by cars using gas or diesel, when distance (in km) is used.

<http://www.ene.gov.on.ca/cons/371706.htm>

Ontario’s Drive Clean Program site.

<http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html>

This site shows that CO<sub>2</sub> emissions from transportation produces about one-third of USA carbon emissions.

*Other Sites*

<http://www.ekes.org/climate/individaction.html>

Individuals taking action to help the environment.

[http://climatechange.sea.ca/climate\\_change.html](http://climatechange.sea.ca/climate_change.html)

An overview of climate change – brief history, the debate, the greenhouse effect, the causes/sources, implications of temperature rise and the Kyoto protocol.

## Appendix 1.1 *Checklist of Preparation - Urban Sprawl and the Environmental Impact of Transportation Choices*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

### Checklist of Preparation

#### I can

- identify short-term and longer-term changes in an ecosystem.
  
- research information about an ecosystem
  
- identify costs and benefits of change
  
- identify chemical products of vehicle exhaust
  
- identify the greenhouse gases produced by various transportation systems
  
- describe safety factors for various transportation systems
  
- identify activities that relate to meeting the goal of the Kyoto Protocol to reduce greenhouse gas emissions
  
- assess the environmental impact of different methods of transportation

## Appendix 1.2 *Summary of the Kyoto Protocol*

Countries around the world have recognized that climate change affects us all. The volume of greenhouse gases produced by human activity, added to the gases occurring naturally in the atmosphere, has led to extreme weather events, temperature changes and the melting of the Arctic icecaps.

In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce greenhouse gas emissions. The agreement that set out those targets, and the options available to countries to achieve them, is known as the Kyoto Protocol. Canada's target is to reduce its greenhouse gas (GHG) emissions to 6 percent below 1990 levels by the period between 2008 and 2012. The goal of Kyoto is to reduce the total emissions of industrialized countries to 5.2% below 1990 levels.

The Government of Canada and the provincial/territorial and municipal governments are working together to achieve reductions in greenhouse gases. Investment in new technologies will help business to operate in a more efficient way and Canadians will benefit by having a cleaner environment. The Kyoto Protocol allows the presence of carbon sinks to count toward a country's commitment to reduce greenhouse gases. A "sink" is any process that removes greenhouse gases from the atmosphere. For example, forests form a carbon "sink" through the process of photosynthesis – trees and other plants take

up carbon dioxide (CO<sub>2</sub>) and break it down. The oxygen (O<sub>2</sub>) is released and the carbon (C) becomes part of the tree.

The Kyoto Protocol allows countries to buy carbon credits from other countries. This means that countries that reduce their greenhouse gas emissions by more than is required under Kyoto can sell their unused carbon credits to countries that find it difficult or expensive to reduce emissions<sup>1</sup>. This is called emissions-reduction trading. In other words, countries that have "overperformed" (met and exceeded their target for reduction) may sell their "unused right to pollute" to countries that have failed to meet their emissions reduction target. Canada believes that a solution that uses the market has a part to play in achieving an overall reduction of greenhouse gases globally.

It is important that countries that have signed the Kyoto Protocol comply with the rules. To that end, Canada is working to build an effective way to measure whether everyone is doing their part. This is a way of checking that countries obey the rules agreed upon, giving them strong incentives to take their commitments seriously.

*Based in part on information found at [www.climatechange.gc.ca](http://www.climatechange.gc.ca).*

*For a glossary of terms, please see the Resources section at the end of this document.*

<sup>1</sup> While it may appear strange that one country can buy the right to pollute from another country, remember that the total emissions of participating countries selling and buying carbon "credits" are to reach the agreed upon targets between 2008 and 2012. Some believe that countries being able to pay others in order to keep polluting is wrong; others say that it is a way of encouraging those who can to make greater reductions while penalizing those who don't.

### Appendix 1.3 *Student Task and Expectations: Urban Sprawl and the Environmental Impact of Transportation Choices*

**Purpose:** Recommend a public transit strategy for a proposed new suburb and assess the impacts of public and private transportation on ecosystems and (over the longer term) climate.

**Background:** The Greater Toronto Area has gone through rapid growth, with urban areas growing into areas that were rural. People that move to these new areas tend to rely on cars for travel. The increase in car traffic requires more roadways and other support structures, such as gas stations. Rapid public transit could reduce the volume of car traffic, but people require reliable service.

Long-time residents of these small towns and rural areas are concerned that various ecosystems are at risk with increased car traffic and building projects. Others focus on how more cars in the area mean more greenhouse gas emissions. They believe that better town planning and transportation planning will mean that fewer cars are needed. Some people want all future development stopped. The provincial government at Queen's Park is reviewing these concerns.

**Scenario:** Plans for a new suburb to be built next to the town of Mediumville are awaiting final government approvals. It is located 100 kilometres outside of Toronto, and will provide housing for people who work in the city but cannot afford homes there.

This new suburb will be built on land that is currently a large farm. It has a wetland and a small forest between the planned subdivision and Toronto. No thought has been given to any kind of organized public transit strategy, either within the suburb, or between it and Toronto. You are asked to identify a public transit strategy for this planned new suburb, in the hopes of addressing some of the current residents' concerns about its impact on the surrounding environment.

**Assignment:** Complete Appendix 1.4 *Environmental Assessment*, Appendix 1.5 *Cost-Benefit Analysis Report Form*, and a letter to your Member of Provincial Parliament (MPP) at Queen's Park. In the letter, suggest a plan of action that helps to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

**Expectations:** Use this list of expectations, along with Appendix 1.1 *Checklist of Preparation* to help you complete your assignment:

- ▶ describe how different ecosystems respond differently to short-term stresses and long-term changes
- ▶ through investigations and applications of basic concepts, identify a current local concern or issue involving an ecosystem [such as the impact of building roads and houses in areas that were fields and forests]

- ▶ through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen
- ▶ assess the impact of technological change on an ecosystem
- ▶ identify and evaluate Canadian initiatives in protecting Canada's ecosystems [such as the Kyoto Protocol]
- ▶ name and write the formulae for common ionic and molecular compounds [such as combustion products of cars]
- ▶ use scientific nomenclature to identify common consumer products relate chemical reactions to familiar processes encountered in everyday life [such as greenhouse gases]
- ▶ identify the impact of climate change on economic, social, and environmental conditions
- ▶ perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
- ▶ investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Appendix 1.4 *Environmental Assessment*

### Summary of the proposed subdivision:

- ▶ To be built next to the town of Mediumville (current population: 10,000), 100 kilometres outside of Toronto
- ▶ Currently, a mix of low density suburban and rural dwellings in the area
- ▶ Building project will mean 3000 new, fully detached houses located just south of Mediumville—expected population increase of approximately 10,000 people

## ENVIRONMENTAL ASSESSMENT

### A. Ecosystems

Features of the ecosystems in the housing development area:

The proposed housing development is situated on farmland that has a wetland and a small forest between the subdivision and Toronto.

Predicted Short-term Ecosystem Changes	Predicted Longer-term Ecosystem Changes
▶	▶
▶	▶
▶	▶

### B. Greenhouse Gases

List the greenhouse gases that will be produced as a result of this new subdivision.

\* Provide names and formulas.

Cars, trucks and heavy machinery	Homes (through heating/cooling and other processes)
▶	▶
▶	▶
▶	▶



## Appendix 1.5 *Cost-Benefit Analysis Form*

Compare the costs and benefits of personal and public transportation.

Transportation Mode	Individual Cost	Environmental Cost	Individual Benefit	Environmental Benefit	Safety
Personal Car					
Public Transportation					

## Appendix 1.6 *Environmental Assessment - sample answers*

### NOTES FOR THE TEACHER

Depending on the resources students are given (and the extent to which the Focus Questions have been used), students' answers may be considerably more extensive.  
*This sample should not be considered comprehensive.*

### A. Ecosystems

Features of the ecosystems in the housing development area:

The proposed housing development is situated on farmland that has a wetland and a small forest between the subdivision and Toronto.

Predicted Short Term Ecosystem Changes	Predicted Longer-term Ecosystem Changes
<ul style="list-style-type: none"> <li>▶ <i>migration of small animals/insects</i></li> <li>▶ <i>soil erosion as land is being cleared for buildings/roads</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>loss of productive farmland</i></li> <li>▶ <i>loss of water filtration capacity as wetland is degraded</i></li> <li>▶ <i>lower water quality as rainwater will run off straight into the river when homes and roads are built</i></li> <li>▶ <i>increase in CO<sub>2</sub> and other greenhouse gases from home energy consumption and vehicle exhaust</i></li> <li>▶ <i>trees and landscaping may be done by homeowners, changing/replacing the forest and wetland habitats</i></li> </ul>

### B. Greenhouse Gases

List the greenhouse gases that will be produced as a result of this new housing development.

\* Provide names and formulas.

Cars, trucks and heavy machinery	Homes (through heating/cooling and other processes)
<ul style="list-style-type: none"> <li>▶ CO<sub>2</sub> carbon dioxide</li> <li>▶ N<sub>2</sub>O nitrous oxide</li> </ul>	<ul style="list-style-type: none"> <li>▶ CO<sub>2</sub> carbon dioxide</li> <li>▶ N<sub>2</sub>O nitrous oxide</li> <li>▶ Halocarbons/chlorofluorocarbons (CFCs)</li> </ul>

### C. The Kyoto Protocol

What is the main goal of the Kyoto Protocol?

*The Kyoto Protocol asks countries to reduce their greenhouse gas emissions which contribute to climate change (6% below 1990 levels in the period 2008-2012).*

What is the link between the Kyoto Protocol and this new subdivision?

*This new housing development will work against Canada's obligations to the Kyoto Protocol since it decreases our carbon sinks (the farmland, the wetland) and increases our carbon sources (through automobile use). Only adding a public transit strategy that gets people out of their cars will help to reduce additional greenhouse gas emissions.*

### D. Reducing Greenhouse Gas Emissions

Reduce greenhouse gas emissions by suggesting different strategies to meet new residents' transportation needs.

Within the new housing development, and between it and the adjacent town of Mediumville	Between the new development and Toronto
<ul style="list-style-type: none"><li>▶ <i>Develop municipal public transit</i></li><li>▶ <i>Create bike/walking trails from the subdivision into Mediumville</i></li><li>▶ <i>Start a walk-to-school program to ensure that students walk rather than be driven</i></li><li>▶ <i>Encourage people to walk/carpool by charging a fee in all town parking lots</i></li></ul>	<ul style="list-style-type: none"><li>▶ <i>Link up with GO Transit bus or rail system</i></li><li>▶ <i>Provide free parking at the GO Transit or railway station</i></li><li>▶ <i>Organize car pools</i></li></ul>

## Appendix 1.7 *Cost-Benefit Analysis—sample answers*

### NOTES FOR THE TEACHER

Depending on the resources students are given (and the extent to which the Focus Questions have been used), students' answers may be considerably more extensive.

*This sample should not be considered comprehensive.*

Transportation Mode	Individual Cost	Environmental Cost	Individual Benefit	Environmental Benefit	Safety
Personal Car	<ul style="list-style-type: none"> <li>▶ <i>Purchase price of car</i></li> <li>▶ <i>Maintenance</i></li> <li>▶ <i>Fuel</i></li> <li>▶ <i>Insurance</i></li> <li>▶ <i>License</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Most burn non-renewable resources</i></li> <li>▶ <i>GHG emissions</i></li> <li>▶ <i>Requires roads that disturb ecosystems</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Available any time (convenient)</i></li> <li>▶ <i>Comfortable</i></li> </ul>		<ul style="list-style-type: none"> <li>▶ <i>Risk of accident is higher than when on public transportation</i></li> </ul>
Public Transportation	<ul style="list-style-type: none"> <li>▶ <i>Cost of ticket</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Some construction along route</i></li> <li>▶ <i>GHG emissions (fewer per person than private automobile)</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Travel time is freed up for activities such as reading, sightseeing, relaxing, sleeping!</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Produces proportionately fewer GHG emissions than car</i></li> <li>▶ <i>Fewer cars on the road</i></li> </ul>	<ul style="list-style-type: none"> <li>▶ <i>Risk of accident is lower than when using personal car</i></li> </ul>

## Appendix 1.8 *Sample Letter to MPP*

Names and address of Members of the Provincial Parliament (MPPs) may be found on the Legislature’s website: <http://olaap.ontla.on.ca/mpp/contact.jsp>

Refer to Appendix 1.11 *Evaluation Rubric for Letter* to make sure you have met the requirements of this assignment.

Date

Your Name

Your Address

MPP Name

MPP Address

Dear Mr./Ms. \_\_\_\_\_:

I am concerned about climate change and I am writing about the subdivision that is planned for Mediumville. I understand that people need a place to live, but I think the subdivision could be built in a way that reduces the impact on the environment.

Canada’s commitment to the Kyoto Protocol means that we will reduce our greenhouse gas emissions to 6% below 1990 levels. The proposed suburb will pave over farmland which produces food and acts as a “sink” to absorb carbon. The subdivision will also create more CO<sub>2</sub> emissions when people use their cars to go to Toronto. Wildlife habitat will also be destroyed.

One of the ways to keep our promise to reduce our greenhouse gas emissions is to get people out of their cars. We need public transportation systems that are affordable and convenient. There should be a local public transit service that links up with the GO Transit system to take people to Toronto. We need sidewalks, bike paths and walking trails so that people will not have to use their cars for all their errands.

I hope you will address the transportation needs of people who will live in Mediumville’s new subdivision so that greenhouse gas emissions will be reduced. In this way, the Ontario government is helping to meet Canada’s Kyoto commitments.

Sincerely,

Your Name

## Appendix 1.9 *Evaluation Rubric for Environmental Assessment*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps.	Concepts are mostly simple and complete.	Ideas are developed in some depth.	Concepts are complete and developed with insight.
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Assessment of impacts of science and technology on the environment	Identifies how an ecosystem is at risk from a specific activity	Explains how an ecosystem at risk is affected by a specific activity	Explains how an ecosystem can be affected by aspects of the specific activity	Explains the impact of different elements of the specific activity on aspects of an ecosystem

### Appendix 1.10 *Evaluation Rubric for Cost-Benefit Analysis*

Description	Level 1	Level 2	Level 3	Level 4
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Assessment of impacts of science and technology on the environment	Identifies how an ecosystem is at risk from a specific activity	Explains how an ecosystem at risk is affected from a certain activity	Explains how an ecosystem can be affected by aspects of the specific activity	Explains the impact of different elements of the specific activity on aspects of an ecosystem
MC Analyses social and economic impact of transportation choices	Social and economic impacts are identified	Social and economic impacts are identified and linked to choices	Social and economic impacts are identified and effectively linked to choices	Social and economic impacts are explained and linked to choices effectively and with insight

### Appendix 1.11 *Evaluation Rubric for Letter to MPP*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts presented	Concepts presented are simple, with gaps.	Concepts are mostly simple and complete.	Concepts are developed with some depth.	Concepts are complete and developed with insight.
K/U Understanding of relationships between concepts	Concepts are presented with limited connections.	Concepts presented show simple connections.	Concepts have clear connections presented.	Concept connections are supported and developed thoroughly.
C Communication of information and ideas	Information and ideas are vague and presented with doubt.	Information and ideas are complicated or difficult to understand.	Information and ideas are presented clearly and understandably.	Information and ideas are presented simply, clearly and are easy to understand.
C Communicates with a purpose for the given audience	Audience and purpose varies.	Audience and purpose consistent.	Clear and consistent sense of audience and purpose.	Strong, clear sense of audience and purpose.
C Use of letter format	Text shows limited command of the formal letter	Text shows moderate command of the formal letter	Text shows considerable command of the formal letter	Text shows extensive command of the formal letter
MC Proposing courses of practical action in response to problems identified	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness

## Task 2. Forestry Management and Climate Change

**Purpose:** To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

**Scenario:** A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will

help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

**Student Task:** Students will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, they will complete a report that outlines how the practices they have described affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of rough work and a list of sources should be included to support the recommendations made. The report should answer the following questions:

- What are good forestry practices?
- How does the chosen method of harvesting and regrowth affect global climate?
- How do these practices reduce the environmental impact on local ecosystems?

### Resources:

Several student worksheets/ resources support the task:

- ▶ Appendix 2.1 *Checklist of Preparation-Forestry Management and Climate Change* helps the student keep track of the information and skills they need to prepare for the assignment;
- ▶ Appendix 1.2 *Summary of the Kyoto Protocol* (see page 18) to provide an overview of the Protocol and its goals;
- ▶ Appendix 2.2 *Student Task and Expectations-Forestry Management and Climate Change* outlines the task and identifies the expectations covered.

Teacher resources have been developed:

- ▶ Strand-by-strand Focus Questions to organize ideas and lessons to support the task;
- ▶ Appendix 2.3 *Evaluation Rubric for Report*.

## Expectations

(Note: examples in square brackets are additions tailored for this resource.)

BY1.06P	describe how different ecosystems respond differently to short-term stresses and long-term changes	CH2.09P	represent simple chemical reactions using word equations, balanced chemical equations, and, where appropriate, molecular models
BY2.04P	through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen	CH3.01P	use scientific nomenclature to identify common consumer products [e.g., common waste products formed by different kinds of technology, such as a chainsaw]
BY2.05P	through investigations and applications of basic concepts, analyse the data and information gathered to clarify aspects of the concern or issue	CH3.03P	relate chemical reactions to familiar processes encountered in everyday life [e.g., identify the waste products created by the operation of different kinds of technology – gasoline vs. diesel vs. an alternative fuel source]
BY2.06P	through investigations and applications of basic concepts, communicate the results of the investigation using a variety of oral, written, and graphic formats	ES1.02P	describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks
BY3.01P	assess the impact of technological change on an ecosystem [e.g., forest harvesting and transportation technology]	ES1.03P	describe and illustrate the factors affecting heat transfer within the water cycle in the atmosphere [e.g., the role of forests as carbon sinks and the release of carbon with a forest fire]
BY3.03P	identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, Ministry of Natural Resources and ISO 14001 for forestry management]		

ES1.06P	describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents [e.g., the global impact of increased energy in the atmosphere]	ES3.01P	identify the impact of climate change on economic, social, and environmental conditions [e.g., what are future considerations for forestry?]
ES1.07P	describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems [e.g., how does climate change explain current severe weather, such as droughts?]	PH3.01P	perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
ES2.01P	through investigations and applications of basic concepts, identify factors that affect the development, severity, and movement of local weather systems [e.g., what forestry activities affect severe weather?]	PH3.02P	investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Prior Learning Required for this Task

*The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 (page 18) for a one-page student summary of the Kyoto Protocol.*

*The Ontario EcoSchools multimedia presentation The Science of Climate Change has been designed specifically for Grade 10 Science (see Resources for ordering information).*

### Fundamental Skills

#### ▸ *Read and Analyse*

Students need to be able to read material and identify/classify key ideas:

**Problem**

**Processes**

**Factors**

**Effects**

**Costs**

**Benefits**

Concept mapping activities or other graphic organizers that help students find and classify information would provide practice.

#### ▸ *Research*

Students need to be able to find information on forest management practices. This may include map-reading skills. From this material, students need to identify how different strategies affect Canada's carbon budget and various ecosystems that are part of or near the forest. Activities that support this require students to find and interpret information. *As students learn about ecosystems in the Biology strand they should work with resources that will be available for this summative task.*

#### ▸ *Systems Analysis*

Students need to be able to identify parts of a system and connections between or among systems. In particular, students need to be able to identify human choices that act as inputs to the forest, affecting not only local ecosystems, but also the potential for future human activities in the area and the long-term yield of forest products.

## Science Background

See “How Approved Textbooks Link to Learning about Climate Change” (pages 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

▶ ***Biology: EcoSystems and Human Activity***

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to identify specific elements in a specific ecosystem to complete the summative task effectively. Succession to a climax forest provides an opportunity to discuss a number of different ecosystems that could be found near a managed forest. Student research and analysis of a specific ecosystem helps develop skills that will be required for this summative task.

▶ ***Chemistry: Chemical Reactions and Their Practical Applications***

Using experiments they can do, or using research skills, students can identify chemical products of various combustion reactions, forest fires and vehicular combustion (gasoline and diesel). Combustion produces CO<sub>2</sub> and also ash that can affect local ecosystems.

▶ ***Earth and Space Science: Weather Systems***

Textbooks often present generic weather information. Students need to be familiar with how to find normal weather patterns for a region that contains an ecosystem of interest. Researching information about weather conditions that increase or decrease the risk of forest fires would be a useful practice for this summative task. Students can also use predictions of future climatic conditions to generalize about the future of forests in different parts of Canada, especially areas in the West.

▶ ***Physics: Motion and Its Applications***

Wood products can be transported in various ways, but trucks are used more frequently at all sites. This requires that roads be built into relatively remote areas. Truck exhaust is a source of heat, and many different chemical products. Students may want to find out how many trucks are required to carry enough logs to make the wood products in a community of single family dwellings. This data can then be used to make generalizations about how much forest is used and the amount of GHGs generated by transporting these products.

## Focus Questions – Climate Change Connections

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

### Biology: EcoSystems and Human Activity

#### Focus Questions

- What are the sources and sinks for carbon in a forest and in the world?
- What roles do forests play in the global carbon budget?
- How does the role of a forest change as it ages or is cut for timber?
- How do forest fires affect the carbon budget?
- What is the impact of forest fires on an ecosystem?
- How does ash affect an ecosystem?
- How are different forests harvested?
- What technological changes have affected cutting and removing timber from a forest?
- What are the impacts of different forestry practices?
- What is meant by “sustainable forestry”?
- How do specific forestry practices link to climate change concerns outlined in the Kyoto Protocol?

#### Climate Change Connections

- ▶ Any model of the carbon cycle for an ecosystem can act as a model for a *carbon budget* for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) by identifying carbon sources and sinks. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- ▶ Forests play a role in the carbon budget. As sinks, a growing forest sequesters CO<sub>2</sub> from the atmosphere. Harvesting forests reduces this activity, but can lead to renewed growth and hence renewed sequestering. Forest fires both deforest the environment and increase CO<sub>2</sub> levels in the atmosphere.
- ▶ Have students consider the role of diversity in an ecosystem. Look specifically at how changing forestry and transportation technologies can affect the ecosystem’s ability to respond to stress, such as forest harvesting or fire. These considerations can then act as a foundation for a broader exploration of sustainability and practices that are consistent with sustainable forests. Link this discussion to the carbon budget model presented above for a better understanding of climate change issues and the goals of the Kyoto Protocol in relation to choices that people make.

## Chemistry: Chemical Reactions and Their Practical Applications

### Focus Questions

- What are the chemical reactions that make up a forest fire?
- How do the products of a forest fire affect an ecosystem?
- What are other chemical reactions that produce greenhouse gases?
- What are other products of other combustion reactions that contribute greenhouse gases to the atmosphere?
- What are other effects on the local environment?
- Which forestry practices produce fewer greenhouse gases?

### Climate Change Connections

- ▶ Forest fires are an example of combustion reactions that form greenhouse gases. Burning fuels for transportation or other technologies can produce greenhouse gases and acid compounds that affect ecosystems. As the concentration of greenhouse gases increases, the impact of these gases on ecosystems and global climate patterns is more severe. The chemistry learned here can be used for later learning about weather and climate patterns.
- ▶ Use specific greenhouse gases and other carbon compounds to reinforce students' understanding of the components of the carbon cycle.
- ▶ Making consumer choices with the environment in mind can be explored. Forestry methods that reduce CO<sub>2</sub> emissions are “green” *practices*. Goods produced through using energy and materials more efficiently are “green” *products*.
- ▶ Forestry methods can be ranked in terms of CO<sub>2</sub> output; some methods are “greener” than others.

## Earth and Space Science: Weather Systems

### Focus Questions

- How does changing the concentration of CO<sub>2</sub> in the atmosphere affect the amount of energy in the atmosphere?
- How does more heat in the atmosphere lead to changes in flow that lead to changing climate?
- How will climate change affect the productivity of forests in Ontario?
- How do forests contribute to reducing the energy imbalance in the atmosphere by removing atmospheric carbon?
- What are the patterns of forest fires?
- How might the change in the distribution of forest fires caused by climate change affect the pattern of forest fires?
- Which forestry practices increase/decrease fire risks?
- How can fire risk be reduced?

## Climate Change Connections

- ▶ Changes to the atmosphere caused by greenhouse gases affect the balance of energy input and energy output for the planet. This is called the global radiation balance. Changing this balance changes the transfer of energy through wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- ▶ Heat transfer is studied in terms of changes in the hydrosphere, where heat transfer takes place and where the consequences develop. Deforestation removes heat sinks and affects the water cycle.
- ▶ Forest composition is related to climate (boreal or mixed deciduous). If global climate changes, the distribution and survival of some forests will change. Such changes will also affect fire patterns. Consider the consequences of shifting wind patterns and ocean current patterns. This is like climate modeling.

## Physics: Motion and Its Application

### Focus Questions

What are the traditional methods of cutting and removing timber from a forest?

How has harvesting technology and transportation technology changed?

How do these new technologies affect forestry practices?

How do different technologies contribute more/less to CO<sub>2</sub> production?

How does satellite technology help track the movement and spread of forest fires?

## Climate Change Connections

- ▶ Compare the CO<sub>2</sub> emissions for different means of transporting wood out of a forest and for different harvesting technologies.
- ▶ Current transportation generally uses fossil fuels, which produce CO<sub>2</sub> and other chemical products.
- ▶ Recent changes in transportation and harvesting technology affect the speed of harvesting an area, and may affect the biodiversity of the area, which could then affect the area's ability for further growth.
- ▶ Satellite technology can be used to track physical conditions and fire patterns.

## Resources

### Textbooks

See “How Approved Textbooks Link to Learning about Climate Change” (pages 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

### Websites

#### *Carbon budget*

[http://www.nrcan.gc.ca/cfs-scf/science/brochure\\_carbon\\_budget/carbon\\_e.html](http://www.nrcan.gc.ca/cfs-scf/science/brochure_carbon_budget/carbon_e.html)

This page explains the carbon budget model and makes specific references to forests and the cycling of carbon in forests at different stages.

<http://www.climatechangesolutions.com/english/science/budget.htm>

Simple explanation of model with sample values.

<http://geochange.er.usgs.gov/pub/carbon/fs97137/>

This is a very useful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

#### *Forests and Forestry*

[http://www.glfc.forestry.ca/science/research/ecolecos\\_e.html](http://www.glfc.forestry.ca/science/research/ecolecos_e.html)

This site has very specific ecosystem information, with a special view towards forests.

<http://ontariosforests.mnr.gov.on.ca/>

The Ontario government’s main page about forestry with many links.

<http://www.algomaforest.com/>

Algoma forestry information.

<http://www.algonquinforestry.on.ca/>

Algonquin forestry information.

<http://www.ene.gov.on.ca/envision/news/2003/070401.htm>

The Ontario government identifies criteria for forest management.

[http://www.nofc.forestry.ca/climate/en/factsheets/factsheets\\_e.html](http://www.nofc.forestry.ca/climate/en/factsheets/factsheets_e.html)

This Environment Canada site links to pages about climate change, carbon budget and a variety of forest types.

[http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9\\_e.html](http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9_e.html)

This site from Environment Canada specifically considers forest fires in the boreal forest.

### *Vehicle Exhaust*

<http://www.osha.gov/SLTC/dieselexhaust/chemical.html>

A good list of many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

<http://www.nrdc.org/air/transportation/ebd/chap2.asp>

Good site with health risks outlined and specific chemical products listed.

### *Weather*

<http://www.ontarioweather.com/summer/forestfire.asp>

These links may not be active at certain times of the year.

<http://www.spruce.ca/PPG/fire/index.htm>

This site has photos of forest fires.

<http://www.fire.uni-freiburg.de/current/Canada.htm>

National fire monitoring and early warning.

### *Transportation*

<http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html>

This site shows that CO<sub>2</sub> emissions from transportation produces about one-third of USA carbon emissions.

<http://www.niwa.cri.nz/ncces/co2calc/>

This New Zealand Residential CO<sub>2</sub> Calculator site allows students to calculate the amount of CO<sub>2</sub> produced by cars using gas or diesel, when distance (in km) is used.

## Appendix 2.1 *Checklist of Preparation - Forestry Management and Climate Change*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

### Checklist of Preparation

#### I can

- identify biotic and abiotic factors in an ecosystem
- research information about an ecosystem and forest management
- describe how forests change over time
- find and interpret data about ecosystems
- ask questions about the impact of chemical processes on the environment
- identify the products of forest fires
- identify the products of vehicle exhaust
- describe how weather can affect conditions for forest fires
- identify how climate change may affect forest fires in the future
- determine how different transportation choices produce more or less CO<sub>2</sub>

## Appendix 2.2 *Student Task and Expectations:* *Forestry Management and Climate Change*

**Purpose:** To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

**Scenario:** A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

**Student Task:** You will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, you will complete a report that outlines good forestry practices, and describe how they affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of your rough work and a list of sources should be included to support the recommendations made. Your report should answer these questions:

- a) What are good forestry practices?
- b) How do these practices reduce the environmental impact on local ecosystems?
- c) How does this management strategy affect global climate?

**Expectations:** Use this list of expectations, along with Appendix 2.1 *Checklist of Preparation* to help you complete your assignment:

- describe how different ecosystems respond differently to short-term stresses and long-term changes
- through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen
- through investigations and applications of basic concepts, analyse the data and information gathered to clarify aspects of the concern or issue
- through investigations and applications of basic concepts, communicate the results of the investigation using a variety of oral, written, and graphic formats
- assess the impact of technological change on an ecosystem [e.g., forest harvesting and transportation technology]

- ▶ identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, Ministry of Natural Resources and ISO 14001 for forestry management]
- ▶ represent simple chemical reactions using word equations, balanced chemical equations, and, where appropriate, molecular models
- ▶ use scientific nomenclature to identify common consumer products [e.g., common waste products formed by different kinds of technology, such as a chainsaw]
- ▶ relate chemical reactions to familiar processes encountered in everyday life [e.g., identify the waste products created by the operation of different kinds of technology – gasoline vs. diesel vs. an alternative fuel source]
- ▶ describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks
- ▶ describe and illustrate the factors affecting heat transfer within the water cycle in the atmosphere [e.g., the role of forests as carbon sinks and the release of carbon with a forest fire]
- ▶ describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents [e.g., the global impact of increased energy in the atmosphere]
- ▶ describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems [e.g., how does climate change explain current severe weather, such as droughts?]
- ▶ through investigations and applications of basic concepts, identify factors that affect the development, severity, and movement of local weather systems [e.g., what forestry activities affect severe weather?]
- ▶ identify the impact of climate change on economic, social, and environmental conditions [e.g., what are future considerations for forestry?]
- ▶ perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
- ▶ investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Appendix 2.3 *Evaluation Rubric for Report*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps.	Concepts are mostly simple and complete.	Ideas are developed with some depth.	Concepts are complete and developed with insight.
K/U Facts and terms used accurately and connect to concepts presented.	Facts and terms are presented with limited accuracy and loosely connect to the concepts presented.	Facts and terms used accurately and appropriately for the concepts presented.	Facts and terms are used accurately and they connect and support concepts presented.	Facts and terms effectively support the ideas presented so that the concepts are understood more easily.
K/U Transfer of concepts to new contexts	Transfers simple concepts to new context	Transfers simple concepts to new contexts with some effectiveness	Transfers both simple and complex concepts to new contexts effectively	Transfers complex concepts to new contexts effectively
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of report form	Limited command of the report form	Moderate command of the report form	Considerable command of the report form	Extensive command of the report form
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Analysis of social and economic issues	Analyses forest practice in terms of simple social and economic issues.	Analyses forest practice in terms of some social and economic issues.	Analyses forest practice in terms of various social and economic issues.	Analyses forest practice in terms of complex social and economic issues.
MC Assessment of impacts of science and technology on the environment	Identifies and assesses how specific forest practice affects the area of interest.	Explains and assesses how specific forest practice affects the area of interest.	Explains and assesses how key forest practices affect the area of interest.	Explains and assesses the impact of varied forest practices on the area of interest.
MC Proposing courses of practical action in relation to identified problems	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness

## ▶ HOW APPROVED TEXTBOOKS LINK TO LEARNING ABOUT CLIMATE CHANGE

Strand	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
<p><b>Biology: Ecosystems and Human Activity</b></p> <ul style="list-style-type: none"> <li>▶ BYV.01P demonstrate an understanding of ecosystems, including the relationship between ecological balance and the sustainability of life</li> <li>▶ BYV.02P analyse natural and human threats to a local ecosystem and propose viable solutions to restore ecological balance</li> <li>▶ BYV.03 relate issues to environmental sustainability with a particular focus on issues in Ontario and Canada</li> </ul>	<ul style="list-style-type: none"> <li>▶ BY1.01P Describe the processes of photosynthesis and cellular respiration as they relate to the cycling of energy, carbon, and oxygen through abiotic and biotic components of an ecosystem</li> <li>▶ BY1.06P Describe how different ecosystems respond differently to short-term stresses and long-term changes</li> <li>▶ BY1.07P Explain how soil composition and fertility can be altered in an ecosystem and outline the possible consequences of such changes</li> <li>▶ BY2.01P Through investigations and applications of basic concepts, identify a current local concern or issue involving an ecosystem</li> <li>▶ BY3.01P Assess the impact of technological change on an ecosystem</li> <li>▶ BY3.03P Identify and evaluate Canadian initiatives in protecting Canada's ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 4-17 (energy in the food chain), 33-34 (human consumption)</li> <li>▶ pp 43-51 (carbon cycling; the cycling of oxygen is not covered)</li> <li>▶ pp 48-49 (carbon cycle, climate activity)</li> <li>▶ pp 26-34 (climate, food, DDT)</li> <li>▶ pp 74-80 (soil)</li> <li>▶ pp 81-91 (succession, ecosystems)</li> <li>▶ pp 454-461 (seasons, latitude, zones)</li> <li>▶ p 53 (human impact on the nitrogen cycle and soil)</li> <li>▶ pp 61-62 (acidity and soil lab)</li> <li>▶ p 63 (biodiversity)</li> <li>▶ pp 74-78 (soil)</li> <li>▶ pp 26-34 (human activity and climate)</li> <li>▶ pp 56-65 (human impact – soil, air, water)</li> <li>▶ pp 88-91 (change – activity and text)</li> <li>▶ pp 96-97 (Environmental Impact Assessment)</li> <li>▶ pp 33-34 (consuming the planet)</li> <li>▶ pp 112-122 (ecological footprint, technology)</li> <li>▶ pp 92-95 (land use)</li> <li>▶ pp 102-122 (managing resources, sustainability)</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 14-15 (ecology)</li> <li>▶ pp 22-25 (energy flow)</li> <li>▶ pp 26-29 (carbon cycle, photosynthesis and cellular respiration)</li> <li>▶ pp 6-13 (human impact, frogs, species at risk)</li> <li>▶ pp 34-37 (pesticides)</li> <li>▶ pp 42-44 (biomes)</li> <li>▶ pp 46-49 (soil)</li> <li>▶ pp 32-33 (fertilizer and ecosystems)</li> <li>▶ pp 52-55 (effects of acid precipitation)</li> <li>▶ pp 56-57 (greening of Sudbury)</li> <li>▶ pp 50-51 (logging forests)</li> </ul>

## How Approved Textbooks Link to Learning about Climate Change (continued)

Strand	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
<p><b>Chemistry: Chemical Reactions and Their Practical Applications</b></p> <ul style="list-style-type: none"> <li>▶ CHV.01P demonstrate an understanding of chemical reactions and the symbolic systems used to describe them</li> <li>▶ CHV.02P investigate chemical reactions encountered in everyday life and their practical applications</li> <li>▶ CHV.03P demonstrate an understanding of how chemical reactions relate to technological products and processes commonly encountered in everyday life</li> </ul>	<ul style="list-style-type: none"> <li>▶ CH1.03P describe, using their observations, the reactants and products of a variety of chemical reactions, including synthesis, decomposition, and displacement reactions</li> <li>▶ CH1.04P describe qualitatively, using their observations, how factors such as heat, concentration, light, and surface area can affect rates of chemical reactions</li> <li>▶ CH1.08P name and write the formulae for common ionic and molecular compounds</li> <li>▶ CH2.09P represent simple chemical reactions using word equations, balanced chemical equations, and, where appropriate, molecular models</li> <li>▶ CH3.01P use scientific nomenclature to identify common consumer products</li> <li>▶ CH3.03P relate chemical reactions to familiar processes encountered in everyday life</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 190-199 (chemical reactions)</li> <li>▶ pp 203-206 (carbon reactions)</li> <li>▶ pp 242-251 (factors that affect chemical reactions)</li> <li>▶ pp 155-166 (chemical names and formulas)</li> <li>▶ pp 170-174 (writing chemical equations)</li> <li>▶ pp 155-162 (naming compounds)</li> <li>▶ pp 200-201 (analyzing an industrial process)</li> <li>▶ pp 231-236 (neutralization reactions)</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 86-87 (describing reactions)</li> <li>▶ pp 92-95 (factors that affect reaction rates)</li> <li>▶ pp 78-80 (naming atoms, ions and compounds)</li> <li>▶ pp 82-83 (polyatomic ions and compounds)</li> <li>▶ pp 90-91 (balancing chemical equations)</li> <li>▶ pp 72-75 (household chemicals)</li> <li>▶ pp 100-102 (food preservation)</li> </ul>

## How Approved Textbooks Link to Learning about Climate Change (continued)

Strand	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
<p><b>Earth and Space Science: Weather Systems</b></p> <ul style="list-style-type: none"> <li>▶ ESV.01P demonstrate an understanding of the factors affecting the fundamental processes of weather systems</li> <li>▶ ESV.02P investigate and analyse trends in local and global weather conditions in order to forecast local weather patterns</li> <li>▶ ESV.03P describe new technologies in meteorology and explain the impact of weather on our daily lives</li> </ul>	<ul style="list-style-type: none"> <li>▶ ES1.01P identify and describe the principal characteristics of the hydrosphere and the four regions of the atmosphere</li> <li>▶ ES1.02P describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks</li> <li>▶ ES1.03P describe and illustrate the factors affecting heat transfer within the water cycle in the atmosphere</li> <li>▶ ES1.06P describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents</li> <li>▶ ES1.07P describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems</li> <li>▶ ES2.01P through investigations and applications of basic concepts, identify factors that affect the development, severity, and movement of local weather systems</li> <li>▶ ES3.01P identify the impact of climate change on economic, social, and environmental conditions</li> <li>▶ ES3.04P assess the impact of weather on a variety of economic activities in Canada</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 441-446 (atmosphere)</li> <li>▶ pp 427-434 (water and energy transfer)</li> <li>▶ pp 435-441 (energy transfer)</li> <li>▶ pp 469-478 (currents, El Niño)</li> <li>▶ pp 422-426 (energy budget outlined)</li> <li>▶ p 446 (gases in the atmosphere)</li> <li>▶ p 447 (weather after global warming activity)</li> <li>▶ pp 462-480 (wind currents, ocean currents)</li> <li>▶ pp 502-512 (severe weather)</li> <li>▶ pp 486-495 (clouds, rain)</li> <li>▶ pp 496-501 (pressure systems)</li> <li>▶ pp 532-538 (forecasting)</li> <li>▶ p 447 (weather after global warming)</li> <li>▶ pp 475-478 (El Niño)</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 222-227 (atmosphere)</li> <li>▶ pp 212-213 (water and weather)</li> <li>▶ pp 214-215 (humidity)</li> <li>▶ pp 216-217 (water evaporation)</li> <li>▶ pp 230-231 (global wind patterns)</li> <li>▶ pp 232-233 (ocean currents)</li> <li>▶ pp 238-239 (extreme weather events)</li> <li>▶ pp 210-211 (regional weather)</li> <li>▶ pp 220-221 (factors that affect climate)</li> <li>▶ pp 234-235 (global weather model)</li> <li>▶ pp 242-243 (global climate)</li> </ul>

## How Approved Textbooks Link to Learning about Climate Change

Strand	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
<p><b>Physics: Motion and Its Applications</b></p> <ul style="list-style-type: none"> <li>▶ PHV.01P describe different kinds of motion and the quantitative relationships among displacement, velocity, and acceleration</li> <li>▶ PHV.02P design and conduct investigations to study the displacement, velocity, and acceleration of a vehicle</li> <li>▶ PHV.03P identify ways in which the principles of motion are used in developing new technologies and describe the consequences of such developments</li> </ul>	<ul style="list-style-type: none"> <li>▶ PH3.01P perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation</li> <li>▶ PH3.02P investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 284-294 (motion, transportation technologies)</li> <li>▶ p 335 (cost-benefit analysis)</li> <li>▶ pp 330-340 (faster technology)</li> <li>▶ pp 402 (speeding, safety, and modern life)</li> <li>▶ pp 330-340 (modes of transport)</li> <li>▶ pp 374-375 (modes of braking)</li> <li>▶ pp 412, 413 (highway technology)</li> </ul>	<ul style="list-style-type: none"> <li>▶ pp 138-139 (traffic on highways)</li> <li>▶ pp 144-145 (choosing a vehicle)</li> <li>▶ pp 158-159 (smart highways)</li> </ul>

## ► TEACHER RESOURCES

### SciencePower 10 Teacher's Resource Binder, Ontario Edition, Blackline Masters

#### **Biology:**

BLM 2-4 It's a Gas

BLM 2-5 Charting Carbon Changes

BLM 2-7 The Greenhouse Effect

BLM 2-8 Follow That Carbon Molecule

BLM 2-16 Dramatic Cycles (if carbon cycle used)

BLM 3-9 Land Use in Southern Ontario

BLM 3-10 Urban Use of Rural Lands

BLM 3-11 The Order of Succession

BLM 3-14 Sustainability at Work

BLM 3-17 Succession and Energy Flow

BLM 3-18 Soil Loss from Clearcutting

BLM 3-19 Remediation and Me

BLM 4-3 Environments in Distress

BLM 4-13 Calculating Ecological Footprints

BLM 4-14 Fossil Fuel Survey

#### **Chemistry:**

BLM 6-14 Naming Hydrocarbons

BLM 6-15 Building Hydrocarbon Models

BLM 6-16 Structural Figures for Hydrocarbons

BLM 6-17 Hydrocarbons in Industry

BLM 6-18 Chemistry Scavenger Hunt

BLM 6-19 Alternative Fuels

BLM 8-1 Factors That Affect Chemical  
Reactions

BLM 9-13 Controlling Harmful Emissions

#### **Earth and Space Science:**

BLM 13-1 Why is the Sky Blue?

BLM 13-2 Absorption or Reflection

BLM 13-3 Earth's Energy Budget Quiz

BLM 13-4 Change in Temperature of Water

BLM 13-9 Review of Energy and Water

BLM 13-10 Does Solar Energy Heat the Air?

BLM 13-12 Levels of the Atmosphere

BLM 13-13 Atmospheric Composition

BLM 14-3 Solar Energy and a Spherical Earth

BLM 14-5 Determining the Direction of  
Prevailing Winds

BLM 14-7 Worldwide Wind Currents Quiz

BLM 14-8 Ocean Gyres

BLM 14-9 The Gulf Stream and Climate

BLM 14-11 El Niño

BLM 14-12 El Niño

BLM 15-20 Severe Weather Quiz

#### **Physics:**

BLM 9-8 Transportation in Canada

BLM 9-11 The Bug Race

## Nelson Science 10 Concepts and Connections: Student Record of Learning

### *Unit 1: Ecosystems and Human Activity*

- 1.1 Disappearing Frogs
- 1.2 Going, Going, Gone!
- 1.3 Ecology
- 1.5 Investigation: A Schoolyard Ecosystem
- 1.7 Energy in Ecosystems
- 1.8 The Carbon Cycle
- 1.10 Explore an Issue: Should We Interfere with Natural Cycles?
- 1.11 Case Study: Pesticides
- 1.15 Soil
- 1.17 Logging Forests
- 1.20 Case Study: The Greening of Sudbury

### *Unit 2: Chemical Reactions and Their Practical Applications*

- 2.1 Case Study: Household Chemicals
- 2.4 Polyatomic Ions and Compounds
- 2.6 Describing Chemical Reactions

### *Unit 3: Motion and Its Applications*

- 3.1 Explore an Issue: Progress and Speed on Canadian Highways
- 3.4 Explore an Issue: How Could You Choose the Best Vehicle?
- 3.10 Case Study: Smart Highways

### *Unit 4: Weather Systems*

- 4.1 Forecasting the Weather
- 4.5 Regional Weather
- 4.6 Water and the Weather
- 4.7 Humidity – Water in the Air
- 4.8 Investigation: What Affects the Evaporation of Water?
- 4.16 Global Weather Model
- 4.18 Case Study: Extreme Weather Events
- 4.20 Explore an Issue: Human Impact on Global Climate

## Nelson Science 10 Teacher's Resource, Blackline Masters

### *Biology: Sustaining Ecosystems*

Blackline Master 2.5 The Carbon Cycle

Blackline Master 3.2 How Does Temperature Affect Seed Germination?

Blackline Master 3.7 What's the Alternative?

Blackline Master 3.10 The Forests of the Temagami Region

Blackline Master 4.5a Areas of Concern in the Great Lakes – St. Lawrence Basin

Blackline Master 4.5b Great Lakes 2000 Cleanup Fund Habitat Rehabilitation Project

### *Chemistry: Chemical Processes*

Blackline Master 5.12 Hydrocarbons Word Search

Blackline Master 7.2 Concentration and Rate

Blackline Master 7.8 Catalytic Converters – Reduce Automobile Pollution, But ...

### *Earth and Space Science: Weather Dynamics*

Blackline Master 13.8 The Saga of a Water Molecule

Blackline Master 14.5 Forms of Precipitation

Blackline Master 15.6c Hurricanes in Canada

Blackline Master 15.12 El Niño Visits Canada

Blackline Master 16.3 Fighting Forest Fires

### *Physics: Motion*

Blackline Master 10.2 Speed Comparisons

Blackline Master 10.10 Acceleration of Different Vehicles: Sample Report

## ► BACKGROUND RESOURCES

### Websites

Climate Change. Government of Canada Environment Canada [www.ec.gc.ca/climate/overview\\_what-e.html](http://www.ec.gc.ca/climate/overview_what-e.html)

This site gives a summary and overview of climate change and links to other Canadian climate change sites.

Climate Change. Government of Canada. [www.climatechange.gc.ca](http://www.climatechange.gc.ca) If you navigate this site's links, you will find information on provincial and territorial regional impacts, health impacts, the greenhouse effect, and a comprehensive overview of all climate change topics. It is ready to read for high school students. Included are global links and a resource list.

Regional Climate Change Poster Series – Climate Change in Canada. Natural Resources Canada. [http://adaptation.nrcan.gc.ca/posters/teachers/lesson\\_e.asp](http://adaptation.nrcan.gc.ca/posters/teachers/lesson_e.asp)

This site provides access to provincial and territorial posters about climate change including a teacher's guide and website. The topics in this poster series focus on weather/climate and ecosystems of Canada. It lists specific outcomes, links to the impacts of climate change on health, community, land, water, coastal regions, and different areas in Canada.

Weather Office. Government of Canada. [http://weatheroffice.ec.gc.ca/Canada\\_e.html](http://weatheroffice.ec.gc.ca/Canada_e.html)

This site offers interactive weather imaging and climate data. It includes seasonal change and forecasts, radarsat images, and the use of technology in weather and climate.

Confronting Climate Change in the Great Lakes Region (2003) Union of Concerned Scientists (UCS) and the Ecological Society of America. [www.ucsusa.org/greatlakes/pdf/solutions\\_ontario.pdf](http://www.ucsusa.org/greatlakes/pdf/solutions_ontario.pdf)

This is a major study written by university and government scientists in the Great Lakes region. Short summaries of the impact of climate change in Ontario and possible solutions have been co-authored by the

David Suzuki Foundation. The solutions section has a helpful discussion of Canada's Kyoto Commitment. [www.ucsusa.org/greatlakes/pdf/solutions\\_ontario.pdf](http://www.ucsusa.org/greatlakes/pdf/solutions_ontario.pdf)

Global Warming Project. North Western University. [www.letus.nwu.edu/projects/gw/navigation.html](http://www.letus.nwu.edu/projects/gw/navigation.html).

This project provides an approach to global warming through three parts: How Does Temperature Change?, What Makes Earth Warm?, and Addressing Climate Change. It has a teacher preparation section and introduction to global warming. The project can be done as a whole or separately to complement your unit.

Background Material. Global Climate Change. [www.ucar.edu/learn/1\\_4\\_1.htm](http://www.ucar.edu/learn/1_4_1.htm).

This site provides a background on climate change and its relation to carbon dioxide. It contains topics such as Climate Past, Present Climates and Human Activity, and Future Climates – the Great Uncertainty. Seven activities links follow that are useful in exploring these topics more thoroughly. They all focus on carbon dioxide.

### Book

Grant, Tim and Gail Littlejohn, eds. *Teaching About Climate Change*. Gabriola Island, B.C.: New Society Publishers, 2001. These essays, both new and updated from *Green Teacher*, focus on the needs of teachers seeking solid background information, a balanced pedagogical strategy and a series of activities to give the subject of climate change a vivid reality. The collection is divided into five sections: Foundations, Energy Alternatives, Transportation Alternatives, The School Building and Home and Community. Includes a broad range of learning activities for all grades. Of special interest for Grade 10 Science students who select the Urban Sprawl and Transportation culminating task are articles on “Investigating Public Transit” and “Counting the Real Cost of Cars” (includes student worksheet). ISBN 086571-437-1

# ONTARIO ECOSCHOOLS PROGRAM

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Lewis Molot, Faculty of Environmental Studies, York University

## **Project Manager**

Eleanor Dudar, Toronto District School Board

## **Assistant Project Manager**

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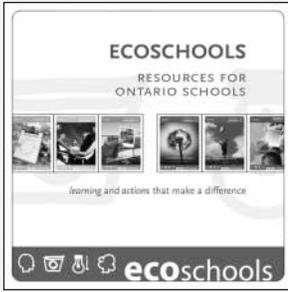
Ron Ballentine, Halton DSB, Science Coordinators' and Consultants' Association of Ontario; Richard Christie, Toronto DSB; Judy Gould, Durham DSB; David Green, Toronto and Region Conservation Authority; Arlene Higgins-Wright, York Region DSB; Lewis Molot, York University; Pam Schwartzberg, Learning for A Sustainable Future

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## **Project Designer**

Comet art + design



## ORDERING INFORMATION

Free copies of all Ontario EcoSchools guides may be downloaded in PDF format from York University's Faculty of Environmental Studies website at [www.yorku.ca/fes/envedu/ecoschools.asp](http://www.yorku.ca/fes/envedu/ecoschools.asp)

The three multimedia presentations are available only on the *EcoSchools Resources for Ontario Schools* CD (both PC and Mac-compatible).

This CD also includes the Ontario EcoSchools guides and curriculum resources and is available for the cost of shipping and handling. For ordering information, please contact:

Library and Learning Resources  
Toronto District School Board  
Tel: 416-397-2595 Fax: 416-395-8357  
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## PROJECT PARTNERS



[www.yorku.ca/fes/envedu/ecoschools.asp](http://www.yorku.ca/fes/envedu/ecoschools.asp)