SUSTAINABLE RESOURCES 11 AND 12

Integrated Resource Package 2008

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Education

IRP 153

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This Integrated Resource Package (IRP) provides basic information teachers will require in order to implement Sustainable Resources 11 and 12. Once fully implemented, this document will supersede the *Resource Sciences 11 and 12 Forests Integrated Resource Package* (1997) and the *Agriculture Curriculum Guide and Resource Book* (1985).

The information contained in this document is also available on the Internet at www.bced.gov.bc.ca/irp/irp.htm

The following paragraphs provide brief descriptions of the components of the IRP.

Introduction

The Introduction provides general information about Sustainable Resources 11 and 12, including special features and requirements.

Included in this section are

- a rationale for teaching Sustainable Resources 11 and 12 in BC schools
- information about graduation program requirements and provincial examinations
- goals for Sustainable Resources 11 and 12
- information about the revision process that led to the publication of this document
- descriptions of the curriculum organizers and suborganizers – groupings for Prescribed Learning Outcomes that share a common focus
- Aboriginal content in the science curriculum
- a graphic overview of the curriculum

Considerations for Program Delivery

This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners.

Prescribed Learning Outcomes

This section contains the Prescribed Learning Outcomes, the legally required content standards for the provincial education system. The Prescribed Learning Outcomes define the required knowledge, skills, and attitudes for each course. They are statements of what students are expected to know and be able to do by the end of the course.

Student Achievement

This section of the IRP contains information about classroom assessment and measuring student achievement, including sets of specific Suggested Achievement Indicators for each Prescribed Learning Outcome. Suggested Achievement Indicators are statements that describe what students are able to do in order to demonstrate that they fully meet the expectations set out by the Prescribed Learning Outcomes. Suggested Achievement Indicators are not mandatory; they are provided to assist in the assessment of how well students achieve the Prescribed Learning Outcomes.

Also included in this section are Key Elements – descriptions of content that help determine the intended depth and breadth of the Prescribed Learning Outcomes.

Glossary

The glossary defines selected terms used in this integrated resource package.

INTRODUCTION

Sustainable Resources 11 and 12

This Integrated Resource Package (IRP) sets out the provincially prescribed curriculum for Sustainable Resources 11 and 12. The development of this IRP has been guided by the principles of learning:

- Learning requires the active participation of the student.
- People learn in a variety of ways and at different rates.
- Learning is both an individual and a group process.

In addition to these three principles, this document recognizes that British Columbia's schools include students of varied backgrounds, interests, abilities, and needs. Wherever appropriate for this curriculum, ways to meet these needs and to ensure equitable access for all learners have been integrated into the Prescribed Learning Outcomes and Suggested Achievement Indicators.

This document represents a revision of the 1997 IRP and the 1985 Curriculum Guide. This updating has been undertaken for the purpose of:

- creating the opportunity for students to explore more resource areas
- clarifying the Prescribed Learning Outcomes
- introducing Suggested Achievement Indicators
- addressing content overload
- reconciling this course with other Science courses
- making the content current
- organizing the content in a more workable way

Rationale

Science education in British Columbia is designed to provide opportunities for students to develop scientific knowledge, skills, and attitudes that will be relevant in their everyday lives and their future careers. In addition to introducing them to current concepts, findings, and processes in various scientific disciplines – biology, physics, chemistry, astronomy, and earth science and geology – it encourages them to:

- develop a positive attitude toward science
- examine basic concepts, principles, laws, and theories through scientific inquiry
- demonstrate respect for precision
- develop awareness of assumptions in all forms of science-related communication
- separate fundamental concepts from the less important or irrelevant
- develop the capacity to think critically, in order to identify supporting or refuting information and bias
- recognize that scientific knowledge is continually developing
- use given criteria for evaluating evidence and sources of information
- actively gain knowledge, skills, and attitudes that provide the basis for sound and ethical problem solving and decision making
- assess the impact of science and technology on individuals, society, and the environment
- cultivate appreciation of scientific endeavour and their potential to contribute to science

To prepare students for further education, for their careers, and for issues they will face in their adult lives, the Sustainable Resources 11 and 12 curriculum engages students in the investigation of scientific questions related to resources found in British Columbia and the development of plausible solutions. Science education develops and builds on students' sense of wonder about the world around them and encourages a feeling of responsibility to sustain it. Science education fosters students' desire to meet a challenge, take risks, and learn from mistakes. It prompts a curiosity about the changing world and helps students understand that the skills and knowledge they are gaining will be refined and expanded to reflect advances in scientific knowledge and technology and changing circumstances in the world around them.

Development and Teaching Considerations

Sustainable Resources 11 is structured on six topic-based curriculum organizers (i.e., Agriculture, Fisheries, Forestry, Mining, Energy, and Career Opportunities).

Sustainable Resources 12 comprises four separate courses, where students explore a resource topic (i.e., Agriculture, Fisheries, Forestry, or Mining) in more detail.

All the Sustainable Resources 11 and 12 courses focus on the following key themes:

- role of resources in society
- importance of resources in society
- First Nations, Métis, and Inuit (FNMI) perspectives
- sustainability and conservation
- environmental responsibility and stewardship
- stakeholder roles, responsibilities, and contributions
- economic influences and impacts
- political influences and impacts
- innovation, research, and technology

Requirements and Graduation Credits

Sustainable Resources 11 and 12 satisfy the Grade 11-12 Graduation Program science requirement.

Sustainable Resources 11, Sustainable Resources 12: Agriculture, Sustainable Resources 12: Fisheries, Sustainable Resources 12: Forestry, and Sustainable Resources 12: Mining are each designated as four-credit courses, and must be reported as such to the Ministry of Education for transcript purposes. Letter grades and percentages must be reported for these courses. It is not possible to obtain partial credit for these courses.

The course codes for Sustainable Resources are

Sustainable Resources 11:	SR 11
Sustainable Resources 12:	
Agriculture	SRA 12
Fisheries	SRFI 12
Forestry	SRFO 12
Mining	SRM 12

Graduation Program Examination

Sustainable Resources 11 and 12 courses do not have a Graduation Program Examination. Students should be advised that some post-secondary institutions require Grade 12 exams to meet entrance requirements, and that writing Grade 12 exams also provides opportunities for provincial scholarships.

Students considering taking Sustainable Resources 11 or 12 to meet graduation requirements should be aware that they might need a Science course with a Graduation Program examination for their post-graduation studies.

For more information, refer to the Ministry of Education examinations web site: www.bced.gov.bc.ca/exams/

Goals for Sustainable Resources 11 and 12

The overriding goals for Sustainable Resources 11 and 12 are in alignment with the foundational statements from the Pan-Canadian Science Framework (Council of Ministers of Education, Canada, 1997) that delineate the four critical aspects of students' scientific literacy.

- **GOAL 1: Science, technology, society, and the environment (STSE)** – Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.
- **GOAL 2: Skills** – Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.
- **GOAL 3: Knowledge** – Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.
- **GOAL 4: Attitudes** – Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

THE 2008 SUSTAINABLE RESOURCES 11 AND 12 REVISION

This revision incorporates components from the *Agriculture Curriculum Guide and Resource Book* (1985) and the Resource Sciences 11 and 12 Forests (1997) curriculum, and contributions of groups of British Columbia educators.

At the same time, the allocation of topics at each grade reflects a commitment by the Ministry of Education to align, where possible and appropriate, the scope and sequence of science education in British Columbia with the scope and sequence outlined in the *K to 12 Common Framework of Learning Outcomes* (developed and published by the Council of Ministers of Education, Canada, under the aegis of the *Pan-Canadian Protocol for Collaboration on School Curriculum*). Among other benefits, it is anticipated that this alignment will facilitate interprovincial transfers for students leaving or arriving in British Columbia and give British Columbia educators access to a wider range of choice when acquiring textbooks and other learning resources to teach Sustainable Resources 11 and 12. A variety of resources were used in the development of this IRP:

- *Agriculture Curriculum Guide and Resource Book* (1985)
- *Resource Sciences 11 and 12 Forests Integrated Resource Package* (1997)
- Provincial science curricula
  - APEF (Atlantic Provinces Education Foundation)
  - Ontario
  - Manitoba
  - Saskatchewan
  - Alberta
- *Shared Learnings* (1998), Aboriginal Education Initiative, British Columbia Ministry of Education

Curriculum Organizers

A curriculum organizer consists of a set of Prescribed Learning Outcomes that share a common focus. The Prescribed Learning Outcomes for Sustainable Resources 11 and 12 are grouped under the curriculum organizers indicated below.

Note that the ordering of organizers and outcomes in the Sustainable Resources 11 and 12 curriculum is not intended to imply an order of instruction.

Grade 11 Curriculum Organizers
Agriculture
Fisheries
Forestry
Mining
Energy
Career Opportunities

Grade 12: Agriculture Curriculum Organizers
Agricultural Elements
Components of Sustainable Agricultural Systems
Agricultural Commodities
Agricultural Supports and Challenges

Grade 12: Forestry Curriculum Organizers
Forest Resources and Society
Forest Ecology
Forest Woodland Operations
Forest Products
Sustainable Forestry Opportunities and Challenges

Grade 12: Fisheries Curriculum Organizers
Fishery Resources and Society
Structure and Function of Aquatic Ecosystems
Sustainable Fishery Operation and Management
Fishery Products
Issues and Challenges Facing Sustainable Fisheries

Grade 12: Mining Curriculum Organizers
Hydrocarbon and Mineral Resources in British Columbia
Geology and Exploration
Extraction and Processing
Sustainability and Environmental Issues
Mining Opportunities and Challenges

COURSE STRUCTURE

Sustainable Resources 11 (Survey course)					
Agriculture	**Fisheries**	**Forestry**	**Mining**	**Energy**	**Career Opportunities**
◊ significance ◊ components ◊ management ◊ production ◊ technology ◊ challenges	◊ significance ◊ ecosystems ◊ management ◊ production ◊ technology ◊ challenges	◊ significance ◊ ecosystems ◊ management ◊ production ◊ technology ◊ challenges	◊ significance ◊ exploration ◊ management ◊ products ◊ technology ◊ challenges	◊ significance ◊ components ◊ management ◊ technology ◊ challenges	◊ career opportunities ◊ safety practices ◊ skills ◊ training

Sustainable Resources 11 and 12 (Integrated goals and considerations)		
◊ become aware of career information ◊ consider First Nations, Métis, and Inuit (FNMI) perspectives ◊ become aware of sustainability and conservation issues	◊ consider environmental responsibility and stewardship ◊ recognize stakeholder contributions, roles, and responsibilities	◊ investigate resource-related innovation/research/technology ◊ recognize economic influences and impacts ◊ recognize political influences and impacts

Sustainable Resources 12 (Resource-specific courses)			
Agriculture	**Fisheries**	**Forestry**	**Mining**
◊ agricultural elements (importance, development, careers) ◊ components of sustainable agricultural systems ◊ agricultural commodities ◊ agricultural supports and challenges	◊ fishery resources and society ◊ structure and function of aquatic ecosystems ◊ sustainable fishery operation and management ◊ fishery products ◊ issues and challenges facing sustainable fisheries	◊ forest resources and society ◊ forest ecology ◊ forest woodland operations ◊ forest products ◊ sustainable forestry opportunities and challenges	◊ hydrocarbon and mineral resources in British Columbia ◊ geology and exploration ◊ extraction and processing ◊ sustainability and environmental issues ◊ mining opportunities and challenges

Aboriginal Content in the Science Curriculum

This curriculum integrates Aboriginal content into the Prescribed Learning Outcomes and Suggested Achievement Indicators in order to help teachers provide all students with an understanding and appreciation of Aboriginal science. Integration of authentic Aboriginal content into the Sustainable Resources curriculum with the support of Aboriginal peoples will help promote understanding of BC's Aboriginal peoples among *all* students.

Incorporating Aboriginal science with western science can provide a meaningful context for Aboriginal students and enhance the learning experience for all students. The inclusion of Aboriginal examples of science and technologies can make the subject more authentic, exciting, relevant, and interesting for *all* students.

Traditional Ecological Knowledge and Wisdom (TEKW) is defined as the study of systems of knowledge developed by a given culture. It brings the concept of wisdom to discussions of resource science. TEKW tends to be holistic, viewing the world as an interconnected whole where humans are not regarded as more important than nature. It is a subset of traditional science and is considered a branch of biological and ecological science. This knowledge, with its characteristic respect for sustaining community and environment, offers proven conceptual approaches that are becoming increasingly important to all residents of British Columbia.

Examples of TEKW science may be accessed through living elders and specialists of various kinds or found in the literature of TEKW: anthropology, astronomy, ethnology, ecology, biology, ethnobiology, medicine, horticulture, agriculture, geology, climatology, architecture, nautical science, engineering, and mathematics. Recognition of the importance of incorporating TEKW into environmental planning is evident in science-based reports and agreements in Canada and internationally. The Brundtland Commission report, *Our Common Future* (World Commission on Environment and Development, 1987), drew our attention to the contributions of traditional knowledge. In British Columbia, the report of the scientific panel for sustainable forest practices in Clayoquot Sound emphasizes TEKW and the importance of including indigenous knowledge in planning and managing traditional territories. The recognition of TEKW globally is addressed in international agreements including the Convention on Biological Diversity, Agenda 21, and UNCED '92, or the Earth Summit at Rio de Janeiro.

Learning Resources

For the current list of Sustainable Resources 11 and 12 recommended learning resources, please check the Learning Resource website: www.bced.gov.bc.ca/irp_resources/lr/resource/gradcoll.htm

The Grade Collection chart lists the recommended learning resources by media format, showing links to the curriculum organizers and sub-organizers. The chart is followed by an annotated bibliography. Teachers should check with suppliers for complete and up-to-date ordering information.

Ministry policy concerning Learning Resources can be found on the ministry's policy website: www.bced.gov.bc.ca/policy/policies

Suggested Timeframe

Provincial curricula are developed in accordance with the amount of instructional time recommended by the Ministry of Education for each subject area. Teachers may choose to combine various curricula to enable students to integrate ideas and make meaningful connections.

Sustainable Resources 11 and 12 courses meet the graduation requirement. They are designed as four-credit courses with an estimated 90 to 110 hours of instructional content each. This estimate is provided as a suggestion only; when delivering the prescribed curriculum, teachers may adjust the instructional time as necessary.

RATIONALE FOR SUSTAINABLE RESOURCES 11

Each resource organizer was selected because of its importance to the economy and to society in British Columbia. With this perspective in mind it is important to integrate, throughout all organizers, content related to jobs and careers to emphasize the importance of these resources to British Columbia and to promote awareness of opportunities for students.

Teachers are encouraged to include additional resource topics as time and interest permits. Topics may focus on local situations so students develop a better understanding of what is happening around them. In this way students may develop an appreciation for their own surroundings.

It is also important for teachers to emphasize the environmental impacts of extracting and processing these resources and the steps being taken to protect the environment.

RATIONALE FOR GRADE 12 COURSES

Each sustainable resource course (Agriculture, Forestry, Fisheries, and Mining) was selected because of its importance to British Columbia society and economy. Integrated throughout all courses should be content related to jobs, careers, technology, and safety to promote awareness of opportunities for students. This career and job exploration should be much broader and more extensive than done in Grade 11 to ensure students have an understanding of direct and indirect career opportunities.

Throughout each course, the impact of extracting and processing the resource on the environment should be emphasized. There should also be discussion around the topic of sustainability and how extracting and processing the resource does not always lead to negative environmental effects.

ESTABLISHING COMMON UNDERSTANDING

After careful consideration, some areas of common consideration were established in order to clarify the intent of the contents of these courses. Since some terms can have broad and varied meanings, the following definitions were established for common understanding:

- *fisheries* refers to activities and processes related to aquatic species (both fresh and salt water) with culturing and/or harvesting potential (commercial and recreational)
- *mining* refers to activities related to both mineral resources and hydrocarbons recovered from fossil fuels
- *sustainability* refers to the conservation, protection, or regeneration of resources over an indefinite period. Central to sustainability is the idea that today's decisions affect the future of human health and well-being, the environment, and the economy. Sustainability requires knowledge and understanding of past events as well as the ability to make informed predictions of future events.

The concept of sustainable development was defined by the World Commission on Environment and Development in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition considers that while development may be essential to satisfy human needs and improve quality of life, it should occur in such a way that the capacity of the natural environment to meet present and future needs is not compromised.

In December 2002, the United Nations adopted a resolution to establish the Decade of Education for Sustainable Development (DESD 2005-2014). Its main goal is to integrate the principles, values, and practices of sustainable development into all aspects of education and learning. It is expected that such educational effort will encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations.

Considerations for Program Delivery

Sustainable Resources 11 and 12

This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners. Included in this section is information about:

- Alternative Delivery policy
- addressing local contexts
- involving parents and guardians
- course requirements respecting beliefs
- safety considerations
- confidentiality
- inclusion, equity, and accessibility for all learners
- working with the school and community
- working with the Aboriginal community
- information and communications technology
- copyright and responsibility

Alternative Delivery Policy

The Alternative Delivery policy does not apply to the Sustainable Resources 11 and 12 curriculum. The Alternative Delivery policy outlines how students, and their parents or guardians, in consultation with their local school authority, may choose means other than instruction by a teacher within the regular classroom setting for addressing Prescribed Learning Outcomes contained in the Health curriculum organizer of the following curriculum documents:

- Health and Career Education K to 7
- Health and Career Education 8 and 9
- Planning 10

The policy recognizes the family as the primary educator in the development of children's attitudes, standards, and values, but the policy still requires that all Prescribed Learning Outcomes be addressed and assessed in the agreed-upon alternative manner of delivery.

It is important to note the significance of the term "alternative delivery" as it relates to the Alternative Delivery policy. The policy does not permit schools to omit addressing or assessing any of the Prescribed Learning Outcomes within the health and career education curriculum. Neither does it allow students to be excused from meeting any Prescribed Learning Outcomes related to health. It is expected that students who arrange for alternative delivery will address the health-related Prescribed Learning Outcomes and will be able to demonstrate their understanding of these Prescribed Learning Outcomes.

For more information relating to alternative delivery, refer to the Ministry of Education website: www.bced.gov.bc.ca/policy/

Addressing Local Contexts

The Sustainable Resources 11 and 12 curriculum includes opportunities for individual teacher and student choice in the focus of topics to meet Prescribed Learning Outcomes. This flexibility enables educators to plan their programs by using examples that are relevant to their local context and to the particular interests of their students. It may be appropriate to incorporate student input when selecting focal areas.

Involving Parents and Guardians

The family is the primary educator in the development of students' attitudes and values. The school plays a supportive role by focussing on the Prescribed Learning Outcomes in the Sustainable Resources 11 and 12 curriculum. Parents and guardians can support, enrich, and extend the curriculum at home.

It is highly recommended that schools inform parents and guardians about the Sustainable Resources 11 and 12 curriculum, and teachers (along with school and district administrators) may choose to do so by

- informing parents/guardians and students of the Prescribed Learning Outcomes for the course (e.g., by sending home class letters, providing an overview during parent-teacher interviews)
- responding to parent and guardian requests to discuss the course, unit plans, and learning resources

Course Requirements Respecting Beliefs

For many students and teachers, the study of some science concepts may lead to issues and questions that go beyond the immediate scope of curriculum (e.g., science is used to meet many industrial requirements, but industrial decision makers must consider factors other than scientific feasibility before adopting a particular process). The technological application of science in areas such as genetic engineering, environmental management, resource development, and industrial processes raises questions of ethics and values. Because these social questions arise, in part, from capabilities that science makes possible, they should be addressed. It must be made clear to students, however, that science only provides the background for what is hoped will be informed personal and social decisions. Questions must be answered objectively and with sensitivity.

Reconciling scientific discoveries (for example, in age dating) and religious faith pose a particular challenge for some students. While respecting the personal beliefs of students, teachers should be careful to distinguish between knowledge based on the application of scientific methods, and religious teachings and associated beliefs (e.g., creationism, divine creation theory, or intelligent design theory).

Safety Considerations

Science education is an activity-based process that provides an exciting method of teaching and learning. However, experiments and demonstrations may involve inherent risks for both teachers and students.

Safety guidelines must be discussed with students. These safety guidelines must support and encourage the investigative approach generally and laboratory instruction specifically, while at the same time promoting safety in the classroom and laboratory. Encouraging a positive safety attitude is a responsibility shared among the board, school administrators, teachers, and students in every school district. The co-operation of all these groups helps develop a strong safety consciousness both inside and outside our schools.

Field work and field trips require special vigilance with respect to traffic and road safety, safe practices in study areas and when obtaining samples, and an awareness of changes in weather.

Another important aspect of in-school safety is the Workplace Hazardous Materials Information Systems (WHMIS). Through labelling, material safety data sheets, and education and training, WHMIS is designed to ensure that those using hazardous materials have sufficient information to handle them safely. Each school district should have an individual trained in WHMIS who can work with teachers to establish safe, well-ventilated classroom and laboratory working conditions. Since the course contained in this Integrated Resource Package may involve work outside of the classroom, it is important for teachers to consider and address all safety issues related to the activities and situations students may find themselves in.

To assist teachers in providing a safe science-learning environment, the Ministry of Education publishes the Science Safety Resource Manual, which has been distributed to every school.

The *Science Safety Resource Manual* is available online:
www.bced.gov.bc.ca/irp/resdocs/scisafety.htm

Confidentiality

The Freedom of Information and Protection of Privacy Act (FOIPPA) applies to students, to school districts, and to all curricula. Teachers, administrators, and district staff should consider the following:

- Be aware of district and school guidelines regarding the provisions of FOIPPA and how it applies to all subjects, including Sustainable Resources 11 and 12.
- Do not use students' Personal Education Numbers (PENs) on any assignments that students wish to keep confidential.
- Ensure students are aware that if they disclose personal information that indicates they are at risk for harm, then that information cannot be kept confidential.

- Inform students of their rights under FOIPPA, especially the right to have access to their own personal information in their school records. Inform parents of their rights to access their children's school records.
- Minimize the type and amount of personal information collected, and ensure that it is used only for purposes that relate directly to the reason for which it is collected.
- Inform students that they will be the only ones recording personal information about themselves unless they, or their parents, have consented to teachers collecting that information from other people (including parents).
- Provide students and their parents with the reason(s) they are being asked to provide personal information in the context of the Sustainable Resources 11 and 12 curriculum.
- Inform students and their parents that they can ask the school to correct or annotate any of the personal information held by the school, in accordance with Section 29 of FOIPPA.
- Ensure students are aware that their parents may have access to the schoolwork they create only insofar as it pertains to students' progress.
- Ensure that any information used in assessing students' progress is up-to-date, accurate, and complete.

For more information about confidentiality, refer to: www.cio.gov.bc.ca/services/privacy/

Inclusion, Equity, and Accessibility for All Learners

British Columbia's schools include young people of varied backgrounds, interests, and abilities. The Kindergarten to Grade 12 school system focusses on meeting the needs of all students. When selecting specific topics, activities, and resources to support the implementation of Sustainable Resources 11 and 12, teachers are encouraged to ensure that these choices support inclusion, equity, and accessibility for all students. In particular, teachers should ensure that classroom instruction, assessment, and resources reflect sensitivity to diversity and incorporate positive role portrayals, relevant issues, and themes such as inclusion, respect, and acceptance.

Government policy supports the principles of integration and inclusion of students for whom English is a second language and of students with special needs. Most of the Prescribed Learning Outcomes and Suggested Achievement Indicators in this IRP can be met by all students, including those with special needs and/or ESL needs. Some strategies may require adaptations to ensure that those with special and/or ESL needs can successfully achieve the Prescribed Learning Outcomes. Where necessary, modifications can be made to the Prescribed Learning Outcomes for students with Individual Education Plans (IEPs).

For more information about resources and support for students with special needs, refer to www.bced.gov.bc.ca/specialed/

For more information about resources and support for ESL students, refer to www.bced.gov.bc.ca/esl/

Working with the School and Community

This curriculum addresses a wide range of skills and understandings that students are developing in other areas of their lives. It is important to recognize that learning related to this curriculum extends beyond the science classroom.

School and district-wide programs support and extend learning in Sustainable Resources. Community organizations may also support the curriculum with locally developed learning resources, guest speakers, workshops, and field studies. Teachers may wish to draw on the expertise of these community organizations and members.

Bringing outside resource people into the classroom is an effective way of reinforcing content, emphasizing and practising listening skills, exposing students to diverse points of view, providing opportunities for discussion and debate, providing a departure point for writing and other activities, and making learning more concrete and relevant. A panel discussion also provides an opportunity for several viewpoints on an issue to be presented at the same time.

To help achieve a successful guest speaker activity, consider the following:

- Determine the nature of the presentation (e.g., lecture, question-and-answer, debate, response to students' presentations, facilitation of a simulation or case study). Ensure that guest speakers are clear about their purpose, the structure, and the time allotted. Also ensure that guests understand the skill and developmental levels of students. Review any materials speakers may use, especially any handouts, for appropriateness.
- Be aware of any district guidelines for external presenters, and ensure that guests have met these guidelines.
- Where appropriate, have students take responsibility for contacting the guest(s) beforehand and making any logistical arrangements.

Working With the Aboriginal Community

The Ministry of Education is dedicated to ensuring that the cultures and contributions of Aboriginal peoples in BC are reflected in all provincial curricula. To address these topics in the classroom in a way that is accurate and that respectfully reflects Aboriginal concepts of teaching and learning, teachers are strongly encouraged to seek the advice and support of local Aboriginal communities. Aboriginal communities are diverse in terms of language, culture, and available resources, and each community will have its own unique protocol to gain support for integration of local knowledge and expertise. To begin discussion of possible instructional and assessment activities, teachers should first contact Aboriginal education co-ordinators, teachers, support workers, and counsellors in their district who will be able to facilitate the identification of local resources and contacts such as elders, chiefs, tribal or band councils, Aboriginal cultural centres, Aboriginal Friendship Centres, and Métis or Inuit organizations.

In addition, teachers may wish to consult the various Ministry of Education publications available, including the "Planning Your Program" section of the resource, *Shared Learnings* (2006). This resource was developed to help all teachers provide students with knowledge of, and opportunities to share experiences with, Aboriginal peoples in BC.

For more information about these documents, consult the Aboriginal Education web site: www.bced.gov.bc.ca/abed/welcome.htm

Information and Communications Technology

The study of information and communications technology is increasingly important in our society. Students need to be able to acquire and analyse information, to reason and communicate, to make informed decisions, and to understand and use information and communications technology for a variety of purposes. Development of these skills is important for students in their education, their future careers, and their everyday lives.

Literacy in the area of information and communications technology can be defined as the ability to obtain and share knowledge through investigation, study, instruction, or transmission of information by means of media technology. Becoming literate in this area involves finding, gathering, assessing, and communicating information using electronic means, as well as developing the knowledge and skills to use and solve problems effectively with the technology. Literacy also involves a critical examination and understanding of the ethical and social issues related to the use of information and communications technology. Sustainable Resources 11 and 12 provides opportunities for students to develop literacy in relation to information and communications technology sources, and to reflect critically on the role of these technologies in society.

Copyright and Responsibility

Copyright is the legal protection of literary, dramatic, artistic, and musical works; sound recordings; performances; and communications signals. Copyright provides creators with the legal right to be paid for their work and the right to say how their work is to be used. The law permits certain exceptions for schools (i.e., specific things permitted) but these are very limited, such as

copying for private study or research. The copyright law determines how resources can be used in the classroom and by students at home.

In order to respect copyright it is necessary to understand the law. It is unlawful to do the following, unless permission has been given by a copyright owner:

- photocopy copyrighted material to avoid purchasing the original resource for any reason
- photocopy or perform copyrighted material beyond a very small part – in some cases the copyright law considers it "fair" to copy whole works, such as an article in a journal or a photograph, for purposes of research and private study, criticism, and review
- show recorded television or radio programs with students in the classroom unless these are copyright cleared for educational use (there are exceptions such as for news and commentaries taped within one year of broadcast that by law have record-keeping requirements – see the web site at the end of this section for more details)
- photocopy print music, workbooks, instructional materials, instruction manuals, teacher guides, and commercially available tests and examinations
- show video recordings at schools that are not cleared for public performance
- perform music or copyrighted material for entertainment (i.e., for purposes other than a specific educational objective)
- copy work from the Internet without an express message that the work can be copied

Permission from or on behalf of the copyright owner must be given in writing. Permission may also be given to copy or use all or some portion of copyrighted work through a licence or agreement. Many creators, publishers, and producers have formed groups or "collectives" to negotiate royalty payments and copying conditions for educational institutions. It is important to know what licences are in place and how these affect the activities schools are involved in. Some licences may also require royalty payments that are determined by the quantity of photocopying or the length of performances. In these cases, it is important to assess the educational value and merits of copying or performing certain works to protect the school's financial exposure (i.e., only copy or use portions necessary to meet educational objectives).

It is important for education professionals, parents, and students to respect the value of original thinking and the importance of not plagiarizing the work of others. The works of others should not be used without their permission.

For more information about copyright, refer to:
www.cmec.ca/copyright/indexe.stm

Prescribed Learning Outcomes

Sustainable Resources 11 and 12

Prescribed Learning Outcomes are content standards for the provincial education system; they are the prescribed curriculum. Clearly stated and expressed in measurable and observable terms, Prescribed Learning Outcomes set out the required knowledge, skills, and attitudes – what students are expected to know and be able to do – by the end of the specified subject and grade.

Understanding the Prescribed Learning Outcomes

Schools have the responsibility to ensure that all Prescribed Learning Outcomes in the selected courses of this curriculum are met. However, teachers have flexibility in determining how delivery of the curriculum can best take place.

It is expected that student achievement will vary in relation to the Prescribed Learning Outcomes. Evaluation, reporting, and student placement with respect to these outcomes are dependent on the professional judgment and experience of teachers, guided by provincial policy.

Prescribed Learning Outcomes for Sustainable Resources 11 and 12 are presented by course and organizer, and are coded alphanumerically for ease of reference. This arrangement, however, is not intended to imply a required instructional sequence.

Wording of the Prescribed Learning Outcomes

All Prescribed Learning Outcomes complete the stem, "It is expected that students will…."

When used in a Prescribed Learning Outcome, the word "including" indicates that any ensuing item **must be addressed**. Lists of items introduced by the word "including" represent a set of minimum requirements associated with the general requirement set out by the outcome. The lists are not necessarily exhaustive. Teachers may choose to address additional items that also fall under the general requirement set out by the outcome.

Conversely, the abbreviation "e.g.," (for example) in a Prescribed Learning Outcome indicates that the ensuing items are provided for illustrative purposes or clarification, and are **not required**. Presented in parentheses, the list of items introduced by "e.g.," is neither exhaustive nor prescriptive, nor is it put forward in any special order of importance or priority. Teachers are free to substitute items of their own choosing that they feel best address the intent of the Prescribed Learning Outcome.

Domains of Learning

Prescribed Learning Outcomes in British Columbia curricula identify required learning in relation to one or more of the three domains of learning: cognitive, psychomotor, and affective. The following definitions of the three domains are based on Bloom's taxonomy.

The **cognitive domain** deals with the recall or recognition of knowledge and the development of intellectual abilities. The cognitive domain can be further specified as including three cognitive levels: knowledge, understanding and application, and higher mental processes. These levels are determined by the verb used in the Prescribed Learning Outcome, and illustrate how student learning develops over time.

- *Knowledge* includes those behaviours that emphasize the recognition or recall of ideas, material, or phenomena.
- *Understanding and application* represents a comprehension of the literal message contained in a communication, and the ability to apply an appropriate theory, principle, idea, or method to a new situation.
- *Higher mental processes* include analysis, synthesis, and evaluation. The higher mental processes level subsumes both the knowledge and the understanding and application levels.

The **affective domain** concerns attitudes, beliefs, and the spectrum of values and value systems.

The **psychomotor domain** includes those aspects of learning associated with movement and skill demonstration, and integrates the cognitive and affective consequences with physical performances.

Domains of learning and, particularly, cognitive levels, inform the design and development of the Graduation Program examinations for many Grade 12 subjects.

Ordering of Organizers and Prescribed Learning Outcomes

It is important to note that the ordering of organizers and Prescribed Learning Outcomes in all Sustainable Resources courses is not intended to imply an order of instruction. Some of the Prescribed Learning Outcomes (e.g., careers) could be integrated throughout all of the organizers to enable students to gain a better understanding of their application, value, and meaning as well as to practise using the skills.

Prescribed Learning Outcomes: Sustainable Resources 11

It is expected that students will:

AGRICULTURE

A1 analyse the environmental, social, and economic significance of agriculture at the local, provincial, and global levels
A2 outline components of agricultural systems and ways of enhancing agriculture production
A3 assess current practices related to sustainable management of agricultural resources in British Columbia
A4 investigate current practices related to the development of commercial agriculture products
A5 illustrate various roles of technology in agricultural practices
A6 analyse challenges and opportunities faced by agriculture industries in British Columbia

FISHERIES

B1 analyse the environmental, social, and economic significance of fisheries at the local, provincial, and global levels
B2 outline the dynamics of ecosystems related to fisheries
B3 assess current practices related to management of sustainable fishery resources in British Columbia
B4 investigate current practices related to the development of fisheries products
B5 illustrate various roles of technology in fishery practices
B6 analyse challenges and opportunities faced by fishery industries in British Columbia

FORESTRY

C1 analyse the environmental, social, and economic significance of forestry and related industries at the local, provincial, and global levels
C2 outline the dynamics of forest ecosystems
C3 assess current practices related to the management of sustainable forest resources in British Columbia
C4 investigate current practices related to the development of commercial forest products
C5 illustrate various roles of technology in forest practices
C6 analyse challenges and opportunities faced by forest industries in British Columbia

MINING

D1 analyse the environmental, social, and economic impacts of acquiring mineral resources, and hydrocarbons from fossil fuels, at the local, provincial, and global levels
D2 describe methods used for the exploration, extraction, and processing of hydrocarbon and mineral resources
D3 assess current practices related to the sustainable management of hydrocarbon and mineral resources in British Columbia
D4 investigate current practices related to the development of hydrocarbon and mineral resource products
D5 illustrate various roles of technology in the exploration, extraction, and processing of hydrocarbon and mineral resources
D6 analyse challenges and opportunities facing hydrocarbon and mineral resource industries in British Columbia

Prescribed Learning Outcomes: Sustainable Resources 11

Energy

E1 analyse the environmental, social, and economic significance of energy generation and use at the local, provincial, and global levels
E2 describe the processes associated with the generation and use of energy resources
E3 investigate current practices related to the management of sustainable energy resources
E4 illustrate various roles of technology in energy resource industries
E5 analyse challenges and opportunities faced by energy industries in British Columbia

Career Topics

F1 research career and job opportunities in resource industries and related services

Prescribed Learning Outcomes: Sustainable Resources 12: Agriculture

It is expected that students will:

AGRICULTURAL ELEMENTS

A1 examine the importance of agricultural resources in the development of Canada with emphasis on British Columbia
A2 assess the impact of agriculture on global development and international relations
A3 critique current trends in societal expectations for agricultural commodities
A4 research career information and job opportunities in diverse agricultural enterprises and related services

COMPONENTS OF SUSTAINABLE AGRICULTURAL SYSTEMS

B1 debate the concept of sustainability as it relates to agriculture
B2 investigate the components of an agricultural system
B3 assess the impact of water management practices on the sustainable production of agricultural commodities
B4 analyse the use of current land and soil management practices on the sustainable production of agricultural commodities
B5 evaluate the roles of various forms of energy in agricultural production
B6 analyse the use of water, fertilizers, pesticides, and pharmaceuticals in agricultural activities
B7 investigate the role of climate in agricultural production

AGRICULTURAL COMMODITIES

C1 identify specific agricultural organisms and associated commodities
C2 outline the structures, roles, and physiological processes of various organisms used in agriculture
C3 assess the importance of animal care and management in agriculture
C4 analyse the effect of agricultural practices and technology on the production of plants and animals

AGRICULTURAL SUPPORTS AND CHALLENGES

D1 assess the effects of policies and practices on agriculture
D2 analyse local practices related to agricultural production
D3 examine challenges related to the safe and efficient production, handling, and distribution of agricultural commodities
D4 discuss environmental issues as they relate to agricultural practices

Prescribed Learning Outcomes: Sustainable Resources 12: Fisheries

It is expected that students will:

Fishery Resources and Society

A1 assess the importance of fisheries in British Columbia and Canada
A2 analyse the impact of fishing and ocean resources on global development and international relations
A3 examine the relationship between fisheries and the development of British Columbia
A4 research career information and job opportunities in fisheries and related services

Structure and Function of Aquatic Ecosystems

B1 examine the biotic and abiotic components of a variety of aquatic ecosystems
B2 investigate interactions found within aquatic ecosystems

Sustainable Fishery Operation and Management

C1 examine methods of assessing fishery stocks
C2 describe harvesting methods associated with wild stock
C3 describe methods used to produce cultured stock
C4 assess management practices related to different fisheries
C5 investigate technologies used in fisheries

Fishery Products

D1 examine the economic benefits derived from fishery products
D2 describe how a variety of fishery products are made
D3 investigate the local, provincial, national, and global marketplace for fishery products
D4 investigate technology and research related to fishery products

Issues and Challenges Facing Sustainable Fisheries

E1 determine environmental issues and challenges related to fisheries
E2 outline economic and political issues and challenges related to fisheries
E3 analyse sustainability issues and challenges related to fisheries
E4 assess issues and challenges related to aquaculture

Prescribed Learning Outcomes: Sustainable Resources 12: Forestry

It is expected that students will:

FOREST RESOURCES AND SOCIETY

A1 assess the importance of forest resources to British Columbia and Canada
A2 report on the distribution of different types of forests found in Canada, with emphasis on British Columbia
A3 examine management needs and practices related to forest resources
A4 analyse current forest management practices

FOREST ECOLOGY

B1 examine the components of forest ecosystems
B2 investigate the interactions found within a forest environment
B3 assess the impact of environmental components and changes on a forest ecosystem
B4 analyse the structure and growth of trees

FOREST WOODLAND OPERATIONS

C1 examine the use of various mapping methods in forestry operations
C2 apply measurement practices to collect data related to forests
C3 investigate practices used in site layout and harvesting of forest resources
C4 investigate technology related to the harvesting, transportation, and processing of forestry resources
C5 assess the post-harvest practices of a managed forest
C6 examine the tools and machinery used in support of safe forestry practices

FORESTRY PRODUCTS

D1 examine the economic benefits derived from forest products
D2 investigate how a variety of forest products are made
D3 explore the local, provincial, national, and global marketplace for forest products
D4 investigate technology and research related to forest products development

SUSTAINABLE FORESTRY OPPORTUNITIES AND CHALLENGES

E1 investigate career information and job opportunities in the forestry sector
E2 analyse current local and global issues in forest management
E3 analyse safety practices related to the forest industry
E4 outline the challenges impacting the health and sustainability of forest resources in British Columbia

Prescribed Learning Outcomes: Sustainable Resources 12: Mining

It is expected that students will:

Hydrocarbon and Mineral Resources in British Columbia

A1 examine the importance of hydrocarbon and mineral resources in British Columbia and Canada
A2 assess the impact of hydrocarbon and mineral exploration and extraction on global development and international relations
A3 analyse the development and growth of the Geological Survey of Canada
A4 examine the relationship between resource exploration and the development of Canada with emphasis on British Columbia
A5 assess the importance of hydrocarbon and mineral resources to Canada's position in world markets
A6 investigate career information and job opportunities in hydrocarbon and mineral resources and related industries

Geology and Exploration

B1 investigate techniques used for hydrocarbon and mineral exploration in British Columbia
B2 examine techniques used for hydrocarbon and mineral identification and assessment
B3 outline the processes required to claim hydrocarbon and mineral rights
B4 assess methods of regulating the environmental impact of hydrocarbon and mineral resource exploration, extraction, and processing in British Columbia
B5 analyse the economic investment and costs needed for a hydrocarbon or mineral extraction project

Extraction and Processing

C1 analyse processes related to planning and designing hydrocarbon or mineral extraction facilities and associated industrial sites
C2 compare and contrast surface mining methods, including financial, environmental, and social risks and benefits
C3 describe subsurface extraction methods for hydrocarbons and minerals, including associated costs, risks, and benefits
C4 investigate methods of processing hydrocarbon and mineral resources

Sustainability and Environmental Issues

D1 evaluate the environmental assessment processes conducted for proposed hydrocarbon and mineral extraction operations and associated processing plants
D2 evaluate the processes of site reclamation during and after hydrocarbon and mineral extraction
D3 assess the future of hydrocarbon and mineral resource development

Mining Opportunities and Challenges

E1 assess the development and use of new extraction and processing methods
E2 analyse environmental impacts of various activities related to hydrocarbon and mineral resource extraction, processing, and use
E3 investigate possible future activities in hydrocarbon and mineral extraction operations (e.g., seafloor, landfills, moon, asteroids)

Student Achievement

Sustainable Resources 11 and 12

This section of the IRP contains information about classroom assessment and student achievement, including specific achievement indicators to assist in the assessment of student achievement in relation to each Prescribed Learning Outcome. Also included in this section are the Key Elements of each course.

Understanding the Key Elements

Key Elements provide an overview of content in each curriculum organizer. They can be used to determine the expected depth and breadth of the Prescribed Learning Outcomes.

Understanding the Achievement Indicators

To support the assessment of provincially prescribed curricula, this IRP includes sets of achievement indicators in relation to each Prescribed Learning Outcome.

Achievement indicators, taken together as a set, define the specific level of knowledge acquired, skills applied, or attitudes demonstrated by the student in relation to a corresponding Prescribed Learning Outcome. They describe what evidence to look for to determine whether or not the student has fully met the intent of the Prescribed Learning Outcome. Each achievement indicator defines only one aspect of the corresponding Prescribed Learning Outcome. It should be noted that the achievement indicators are designed to be considered as an entire set when determining whether students have fully met the Prescribed Learning Outcome.

In some cases, achievement indicators may also include suggestions as to the type of task that would provide evidence of having met the Prescribed Learning Outcome (e.g., a constructed response such as a list, comparison, analysis, or chart; a product created and presented such as a report, drama presentation, poster, letter, or model; a particular skill demonstrated such as interpreting graphs).

Achievement indicators support the principles of assessment *for* learning, assessment *as* learning, and assessment *of* learning. They provide teachers and parents with tools that can be used to reflect on what students are learning, as well as provide students with a means of self-assessment and ways of defining how they can improve their own achievement.

Achievement indicators are not mandatory; they are suggestions only, provided to assist in the assessment of how well students achieve the Prescribed Learning Outcomes.

Classroom Assessment and Evaluation

Assessment is the systematic gathering of information about what students know, are able to do, and are working toward. Assessment evidence can be collected using a wide variety of methods, such as:

- observation
- student self-assessments and peer assessments
- quizzes and tests (written, oral, practical)
- samples of student work
- projects and presentations
- oral and written reports
- journals and learning logs
- performance reviews
- portfolio assessments

Assessment of student performance is based on the information collected through assessment activities. Teachers use their insight, knowledge about learning, and experience with students, along with the specific criteria they establish, to make judgments about student performance in relation to Prescribed Learning Outcomes.

Three major types of assessment can be used in conjunction to support student achievement.

- Assessment for learning is assessment for the purpose of greater learning achievement.
- Assessment as learning is assessment as a process of developing and supporting students' active participation in their own learning.
- Assessment of learning is assessment for the purpose of providing evidence of achievement for reporting.

Assessment for Learning

Classroom assessment for learning provides ways to engage and encourage students to become involved in their own day-to-day assessment – to acquire the skills of thoughtful self-assessment and to promote their own achievement. This type of assessment serves to answer the following questions:

- What do students need to learn to be successful?
- What does the evidence of this learning look like?

Assessment for learning is criterion-referenced, in which a student's achievement is compared to established criteria rather than to the performance of other students. Criteria are based on Prescribed Learning Outcomes and suggested Achievement Indicators or other learning expectations.

Students benefit most when assessment feedback is provided on a regular, ongoing basis. When assessment is seen as an opportunity to promote learning rather than as a final judgment, it shows students their strengths and suggests how they can develop further. Students can use this information to redirect their efforts, make plans, communicate with others (e.g., peers, teachers, parents) about their growth, and set future learning goals.

Assessment for learning also provides an opportunity for teachers to review what their students are learning and what areas need further attention. This information can be used to inform teaching and create a direct link between assessment and instruction. Using assessment as a way of obtaining feedback on instruction supports student achievement by informing teacher planning and classroom practice.

Assessment as Learning

Assessment as learning actively involves students in their own learning processes. With support and guidance from their teacher, students take responsibility for their own learning, constructing meaning for themselves. Through a process of continuous self-assessment, students develop the ability to take stock of what they have already learned, determine what they have not yet learned, and decide how they can best improve their own achievement.

Although assessment as learning is student-driven, teachers can play a key role in facilitating how this assessment takes place. By providing regular opportunities for reflection and self-assessment, teachers can help students develop, practise, and become comfortable with critical analysis of their own learning.

Assessment of Learning

Assessment of learning can be addressed through summative assessment, including large-scale assessments and teacher assessments. These assessments can occur at the end of the year or at periodic stages in the instructional process.

Large-scale assessments, such as Foundation Skills Assessment (FSA) and Graduation Program exams, gather information on student performance throughout the province and provide information for the development and revision of curriculum. These assessments are used to make judgments about students' achievement in relation to provincial and national standards. There is no large-scale provincial assessment for Sustainable Resources 11 and 12.

Assessment of learning is also used to inform formal reporting of student achievement.

For Ministry of Education reporting policy, refer to: www.bced.gov.bc.ca/policy/policies/student_reporting.htm

For more information about assessment for, as, and of learning, refer to *Rethinking Assessment with Purpose in Mind*, developed by the Western and Northern Canadian Protocol (WNCP).

This resource is available online at www.wncp.ca

Assessment *for* Learning	Assessment *as* Learning	Assessment *of* Learning
Formative assessment is *ongoing in the classroom* • teacher assessment, student self-assessment, and/or student peer assessment • criterion-referenced – criteria based on Prescribed Learning Outcomes identified in the provincial curriculum, reflecting performance in relation to a specific learning task • involves both teacher and student in a process of continual reflection and review about progress • teachers adjust their plans and engage in corrective teaching in response to formative assessment	**Formative assessment is** *ongoing in the classroom* • self-assessment • provides students with information on their own achievement and prompts them to consider how they can continue to improve their learning • student-determined criteria based on previous learning and personal learning goals • students use assessment information to make adaptations to their learning process and to develop new understandings	**Summative assessment occurs** *at end of year or at key stages* • teacher assessment • may be either criterion-referenced (based on Prescribed Learning Outcomes) or norm-referenced (comparing student achievement to that of others) • information on student performance can be shared with parents/guardians, school and district staff, and other education professionals (e.g., for the purposes of curriculum development) • used to make judgments about students' performance in relation to provincial standards

Criterion-Referenced Assessment and Evaluation
In criterion-referenced evaluation, a student's performance is compared to established criteria rather than to the performance of other students. Evaluation in relation to prescribed curriculum requires that criteria be established based on the learning Prescribed Learning Outcomes.

Criteria are the basis for evaluating student progress. They identify, in specific terms, the critical aspects of a performance or product that indicate how well the student is meeting the Prescribed Learning Outcomes. For example, weighted criteria, rating scales, or scoring guides (reference sets) are ways that student performance can be evaluated using criteria.

Wherever possible, students should be involved in setting the assessment criteria. This helps students develop an understanding of what high-quality work or performance looks like.

Criterion-referenced assessment and evaluation may involve these steps:	
Step 1	Identify the Prescribed Learning Outcomes and Suggested Achievement Indicators (as articulated in this IRP) that will be used as the basis for assessment.
Step 2	Establish criteria. When appropriate, involve students in establishing criteria.
Step 3	Plan learning activities that will help students gain the knowledge, skills, and attitudes outlined in the criteria.
Step 4	Prior to the learning activity, inform students of the criteria against which their work will be evaluated.
Step 5	Provide examples of the desired levels of performance.
Step 6	Conduct the learning activities.
Step 7	Use appropriate assessment instruments (e.g., rating scale, checklist, scoring guide) and methods (e.g., observation, collection, self-assessment) based on the particular assignment and student.
Step 8	Review the assessment data and evaluate each student's level of performance or quality of work in relation to criteria.
Step 9	Where appropriate, provide feedback and/or a letter grade to indicate how well the criteria are met.
Step 10	Communicate the results of the assessment and evaluation to students and parents/guardians.

Student Achievement

Sustainable Resources 11

Key Elements: Agriculture

By the end of this organizer, students will understand the elements, practices, and issues related to agriculture and the tools and processes for producing and bringing products to the consumer. Students will have analysed the economic, environmental, and social significance of agriculture from a local, provincial, and global perspective. Students will also have had the opportunity to develop an understanding of the technology associated with agriculture and to look at careers related to agriculture industries.

Vocabulary

Agricultural Land Reserve (ALR), biofuel, breeding, crop rotation, feedlot, gene pool, genetic alteration, organic method, tillage

Knowledge

- importance of agriculture
- components of agricultural systems
- management practices related to agricultural systems
- ways of enhancing agricultural production
- roles of technology in agriculture
- challenges facing agricultural industries
- career opportunities in agriculture
- safety considerations in agriculture

Skills and Attitudes

- identification of organisms used to produce agricultural products
- recognition of the need for managed agricultural activities
- support of sustainable agricultural practices
- understanding of safe practices related to agricultural activities

Prescribed Learning Outcomes	Suggested Achievement Indicators: Agriculture
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
A1 analyse the environmental, social, and economic significance of agriculture at the local, provincial, and global levels	❑ identify major agriculture areas/activities in BC (e.g., Fraser Valley, Okanagan, Peace River) and their characteristics ❑ identify the impact of government regulations on agriculture (e.g., Agricultural Land Reserve, marketing boards) ❑ describe current global market and product trends related to British Columbia agriculture ❑ research and report on agriculture contributions to the BC economy, including the multiplier effect of the food industries ❑ explain how current agricultural practices compare to traditional practices (e.g., Aboriginal, communal societies, family farm, orchards, vineyards) ❑ outline environmental issues that arise as a result of agricultural activities
A2 outline components of agricultural systems and ways of enhancing agriculture production	❑ outline a range of agricultural pursuits (e.g., ranching, dairy, grain, poultry, horticulture, biofuel, market gardening) ❑ describe ecological requirements (e.g., soil, water, nutrients, pollinators, water cycle, climate) for producing agricultural commodities (e.g., grains, animals, flowers, biofuels, fibres) ❑ identify fungi, plants, animals, birds, insects, and fish used to produce agricultural products ❑ describe practices that enhance agricultural production (e.g., pest control, fertilizer, organic methods, crop rotation, vaccinations, tillage) ❑ describe, using examples, the effects of – genetic alteration on plant production – selective breeding on animal production
A3 assess current practices related to sustainable management of agricultural resources in British Columbia	❑ define the concept of sustainable agriculture ❑ identify the factors that affect the sustainability of an agricultural system (e.g., population growth, urbanization, economic activity, soil depletion, loss of agricultural land) ❑ compare different scales of agriculture (eg. family farms, communal farms) ❑ discuss competing land use interests (e.g., agricultural use, wildlife habitat, urban expansion, recreation demands)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Agriculture
A4 investigate current practices related to the development of commercial agriculture products	❑ describe a variety of BC agriculture products ❑ investigate the influence of supply and demand on agricultural decisions (e.g., food trends, cultural perception, social status, organic food preferences, local vs. transported/global products, seasonal diet, genetic alteration concerns) ❑ illustrate the effect of innovation on agricultural production (e.g., organic methods, pharmaceuticals, fibre production, biofuel) ❑ determine the effect of marketing on agricultural production (e.g., new product development, advertising campaigns, changing markets, meeting cultural requirements)
A5 illustrate various roles of technology in agricultural practices	❑ describe technological innovations in breeding and pest management ❑ discuss the role of technology in the production, processing, transporting, and marketing of agricultural products ❑ outline the effect of technology on agriculture operations
A6 analyse challenges and opportunities faced by agriculture industries in British Columbia	❑ identify challenges (e.g., land use and development, loss of infrastructure) and opportunities (e.g., agritourism, niche markets) found in agriculture industries ❑ discuss the effects of changing costs (e.g., transportation, labour, fuel, commodities, land) on agriculture industries ❑ outline the effects of political change (e.g., ALR decisions, land treaties) on agriculture ❑ outline ways (e.g., BC Environmental Farm Plan) to minimize negative environmental effects (e.g., pollution from feed lots, contamination of gene pools by GM organisms) of agricultural pursuits

Key Elements: Fisheries

By the end of this organizer, students will understand the elements and issues related to fishery systems and the tools and processes for producing and bringing products to the consumer. Students will have analysed the economic, environmental, and social significance of fisheries from a local, provincial, and global perspective. Students will also have an understanding of the components and dynamics of aquatic ecosystems. Students will have had the opportunity to develop an understanding of the technology associated with fisheries and to look at careers related to fishery industries.

Vocabulary

aquaculture, by-catch, cultured, drift-net fishing, energy flow, extirpated, filter feeder, finfish, *Fisheries Act*, fry, grazer, hatchery, invertebrate, maximum sustainable yield, net pen, Pacific Salmon Commission, parasite, predator, producer, salmonid, scavenger, shellfish, sounder, *Species at Risk Act* (SARA), stock, troll, vertebrate

Knowledge

- economic, environmental, and social significance of fisheries
- components and dynamics of fishery ecosystems
- management practices related to various types of fisheries
- practices related to production of fishery products
- career opportunities in fisheries
- safety considerations in fisheries

Skills and Attitudes

- illustration of aquatic food webs
- understanding of the need for managed fisheries
- support of sustainable fisheries practices
- understanding of safe practices related to fishery activities

Prescribed Learning Outcomes	Suggested Achievement Indicators: Fisheries
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
B1 analyse the environmental, social, and economic significance of fisheries at the local, provincial, and global levels	❑ describe British Columbia licence types (e.g., species) and categories (e.g., commercial, sport, Aboriginal, aquaculture) ❑ explain past and present fishery methods (e.g., nets, trolling, net pens) used in British Columbia ❑ describe the impact of international agreements (e.g., Pacific Salmon Commission) on fishing industries ❑ outline the contribution of the commercial, sport, aquaculture, and Aboriginal fishing sectors to the provincial economy ❑ explain how British Columbia's unique geography allows for diverse fishing practices ❑ report on the historical and contemporary importance of fishing to British Columbia Aboriginal peoples ❑ analyse the direct impact of threats to habitat and habitat loss on fisheries
B2 outline the dynamics of ecosystems related to fisheries	❑ define each of the following terms: invertebrates, vertebrates, producers, filter feeders, grazers, scavengers, predators ❑ identify the characteristics of fresh water and marine ecosystems ❑ describe the life cycle of salmonids ❑ illustrate an aquatic food web including types of organisms and energy flow ❑ identify fishery species (e.g., finfish, shellfish, marine plants) harvested in British Columbia ❑ describe how human activities away from the water impact the health of the aquatic environment ❑ list factors that influence the survival of wild species (e.g., climatic variation, population dynamics, fishing pressure, habitat pressure, diseases, parasites)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Fisheries
B3 assess current practices related to management of sustainable fishery resources in British Columbia	❑ define terms (e.g., stock assessment, harvesting regulations, population modelling, by-catch monitoring, wild stock, farmed stock, maximum sustainable yield) and species (e.g., finfish, shellfish, marine plants) used in fisheries ❑ outline the role of regulations (e.g., *Canada's Species at Risk Act* (SARA), *Fisheries Act*) in managing fishery resources ❑ identify examples of British Columbia aquatic species at risk (e.g., extinct, extirpated, endangered, threatened, of special concern) and outline pressures on these species ❑ describe the processes related to fishery enhancement (e.g., hatcheries, spawning channels, stocked lakes, habitat modification) ❑ analyse the elements of healthy management practices in aquaculture (e.g., location, diet, health, waste) ❑ identify pros and cons of different fishery management practices (e.g., stocking, quotas, gear restrictions, season restrictions, area restrictions), including in other jurisdictions (e.g., Alaska, Japan, east coast of Canada)
B4 investigate current practices related to the development of fisheries products	❑ describe a range of fisheries products (e.g., food, fertilizers, meals, pet foods, vitamin supplements) ❑ compare and contrast different methods of production (e.g., canning, smoking, freezing, vacuum packaging) ❑ analyse different scales of production (e.g., local, regional, and international production, shore-based canning vs. factory ships)
B5 illustrate various roles of technology in fishery practices	❑ explain the role of technology in aquaculture and fisheries enhancement (e.g., tagging, hatcheries, fry survival) ❑ describe the technology involved in navigation and harvesting (e.g., GPS, satellite technology, types of sounders) ❑ identify technologies associated with fresh water fishing
B6 analyse challenges and opportunities faced by fishery industries in British Columbia	❑ identify factors that affect the sustainability of fisheries (e.g., personal choices that may impact aquatic environments, environmental change, international policies) ❑ assess the impact of various factors on the sustainability of fisheries (e.g., over-fishing, drift-net fishing, environmental degradation, weather/water current patterns, climate changes) ❑ describe challenges and opportunities faced by fishery industries (e.g., Aboriginal and international treaty negotiations, marketing, competing products) ❑ identify actions that government and/or fishery industries have taken to address challenges facing fisheries

SUSTAINABLE RESOURCES 11

Key Elements: Forestry

By the end of this organizer, students will understand the elements and issues related to forest systems and their management. Students will have gained familiarity with the processes for producing forest products and will have analysed the economic, environmental, and social significance of forestry from a local, provincial, and global perspective. Students will have had the opportunity to develop an understanding of the technology associated with forestry and to look at careers related to forestry industries.

Vocabulary

angiosperm, biodiversity, biofuel, composite beam, consumer, decomposer, ecosystem, fibreboard, gymnosperm, hardwood, harvesting, integrated resource management, kraft, old growth, particleboard, primary, producer, silvicultural systems, silviculture, softwood, treaty

Knowledge

- economic, environmental, and social significance of forestry and forestry related industries
- components and dynamics of forest ecosystems
- current practices related to managing forest resources
- current practices related to harvesting and the production of commercial forest products
- career opportunities in forestry

Skills and Attitudes

- illustration of forest food webs
- understanding of sustainable forest practices
- support of sustainable forest practices
- understanding of safe practices related to forestry activities

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forestry
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
C1 analyse the environmental, social, and economic significance of forestry and related industries at the local, provincial, and global levels	❑ outline the benefits and costs of forest resource development ❑ explain the importance of forestry resources to society (e.g., social, recreational, economic, environmental) ❑ explain how personal and societal needs, wants, beliefs, and actions may influence the forest resource ❑ compare past and present uses of forests in British Columbia, Canada, and other areas of the world (e.g., Aboriginal use, ranching, mining, recreation) ❑ outline environmental issues that arise as a result of forestry industries
C2 outline the dynamics of forest ecosystems	❑ define ecology, environment, ecosystem, and biodiversity ❑ identify components (biotic and abiotic) of forest ecosystems ❑ explain the structure and function of trees (e.g., softwood vs. hardwood) ❑ describe the life cycle of an angiosperm and a gymnosperm ❑ illustrate how forests are complex ecosystems ❑ summarize interactions of components, biotic and abiotic, of local forest ecosystems (e.g., interaction of producers with consumers; decomposers; soil, rock, and water)
C3 assess current practices related to the management of sustainable forest resources in British Columbia	❑ differentiate between public and private forest land use ❑ identify stakeholder groups (e.g., forest industry, ranchers, conservation, recreation, tourism, wild crafters, outfitters, Aboriginal peoples) ❑ outline goals and methods for conducting resource inventories of forests ❑ analyse essential elements required for forest management (e.g., stakeholder consultation, certification, regulations, planning, inventory, harvesting, silviculture, protection)
C4 investigate current practices related to the development of commercial forest products	❑ describe a variety of primary (e.g., lumber), secondary (e.g., composite beams) and tertiary (e.g., rayon) forest products ❑ describe a range of fibre (e.g., lumber, pulp) and non-fibre (e.g., fur, food, medicine) forest products ❑ compare and contrast different methods of production (e.g., kraft vs. mechanical pulp, particleboard vs. fibreboard, fibreboard vs. plywood) ❑ analyse different scales of production (e.g., portable sawmilling vs. large mill production)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forestry
C5 illustrate various roles of technology in forest practices	❑ identify examples of current and emerging technologies used in the forest industry ❑ describe tools and methods used in collecting forest survey data ❑ explain roles of research and technology in forestry (e.g., new wood products, forest fire preventions, biofuels) ❑ describe technologies involved in the harvesting of forest resources ❑ identify technologies involved in silviculture (e.g., stock production, genetic alteration)
C6 analyse challenges and opportunities faced by forest industries in British Columbia	❑ explain the principles of multiple and integrated land use ❑ describe challenges and opportunities faced by forest industries (e.g., land claims and treaty negotiations, marketing, international treaties, competing products) ❑ identify actions that government and/or forest industries have taken to address issues related to forest practices (e.g., old growth management areas, areas of significant cultural/historical value, preservation of biodiversity, regulations) ❑ analyse challenges related to conservation of wildlife and natural landscapes

SUSTAINABLE RESOURCES 11

Key Elements: Mining

By the end of this organizer, students will understand the processes and issues related to hydrocarbon and mineral resource exploration, extraction, and processing. Students will have analysed the economic, environmental, and social significance of mining from a local, provincial, and global perspective. They will have had the opportunity to develop an understanding of the technology associated with resource exploration and extraction, and to look at careers related to mining industries.

Vocabulary

capitalization, commodity, concentrating, cracking, fossil fuel, geophysical survey, grade, hydrocarbon, mineral, mining, ore, placer, prospecting, reclamation, refining, resources, smelting, tailings, trenching

Knowledge

- economic, environmental, and social significance of using hydrocarbon and mineral resources
- methods used for the exploration, extraction, and processing of hydrocarbon and mineral resources
- environmental impact of extracting hydrocarbon and mineral resources
- current management practices related to hydrocarbon and mineral resource exploration, extraction, and processing
- roles of technology in the exploration, extraction, and processing of hydrocarbon and mineral resources and products
- career opportunities in mining

Skills and Attitudes

- appreciation of the complexity of exploration, extraction, and processing of mining resources
- support of sustainable management of mining resources
- understanding of safe practices related to mining activities

Prescribed Learning Outcomes	Suggested Achievement Indicators: Mining
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
D1 analyse the environmental, social, and economic impacts of acquiring mineral resources, and hydrocarbons from fossil fuels, at the local, provincial, and global levels	❑ outline the history of mining and its impact on the development of British Columbia and Canada (e.g., migration, trade, Aboriginal knowledge) ❑ identify impacts of fossil fuels (oil, gas, coal) and mineral exploration and mining activities on society (e.g., social, economic, environmental) ❑ assess the benefits and challenges (e.g., economic, employment, transportation infrastructure, environmental) of finding and developing fossil fuels and mineral resources ❑ analyse the impacts of global markets and demand for mineral resources and hydrocarbons recovered from fossil fuels on British Columbia's economy ❑ outline environmental issues that arise as a result of hydrocarbon extraction and mining activities
D2 describe methods used for the exploration, extraction, and processing of hydrocarbon and mineral resources	❑ identify hydrocarbon and metallic and non-metallic mineral resources found in British Columbia ❑ examine the history of the exploration for hydrocarbon and metallic and non-metallic mineral resources in British Columbia ❑ outline exploration methods and techniques used to detect and evaluate hydrocarbon and mineral resources (e.g., geophysical studies, drilling) ❑ describe a variety of surface and subsurface extraction methods for hydrocarbon and mineral resources ❑ describe hydrocarbon refining methods (e.g., hydrocarbon cracking and fractionation) and mineral resource processing methods (e.g., screening, smelting, concentrating)
D3 assess current practices related to the sustainable management of hydrocarbon and mineral resources in British Columbia	❑ describe processes and regulations related to mine development (e.g., capitalization, stakeholder consultations, environmental assessment, land title) ❑ outline factors, operating costs, and regulations related to mine economics and costing (e.g., ore deposit grade, size, and location; flow rate, size, and location of oil and gas reservoirs; taxation, royalties, commodity prices, labour costs, energy costs, current technology, regulations) ❑ discuss environmental concerns related to hydrocarbon and mineral resource extraction and processing (e.g., safe exploration and transportation of hydrocarbons, mine tailings management, acid-rock drainage and water quality management, waste management, waste-rock disposal, reclamation)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Mining
D4 investigate current practices related to the development of hydrocarbon and mineral resource products	❑ identify types of hydrocarbon and mineral resource products (e.g., jet fuel, asphalt, plastics, cosmetics, fertilizers, metals, alloys, industrial minerals, gems, jade, construction materials) ❑ compare different methods of processing hydrocarbon and mineral resources (e.g., refining, cracking, concentrating, smelting) ❑ compare scales of production (e.g., placer, large scale open pit mining operations, underground mining, gravel pits, peat farms)
D5 illustrate various roles of technology in the exploration, extraction, and processing of hydrocarbon and mineral resources	❑ describe the use of technology in – exploration (e.g., soil sampling, rock sampling, trenching, remote sensing, satellite imaging, drilling, geological mapping) – extraction (e.g., small scale placer operations, large scale equipment, GPS dispatch systems, use of robotics) – processing (e.g., fractionation, concentrating, smelting)
D6 analyse challenges and opportunities facing hydrocarbon and mineral resource industries in British Columbia	❑ identify opportunities for new hydrocarbon and mineral resource operations in British Columbia (e.g., exploration in pine beetle kill areas) ❑ describe challenges and opportunities faced by the industries (e.g., reprocessing, depletion of oil, gas, coal and mineral reserves, site reclamation, environmental impact, investment requirements, fluctuations in exploration and development costs, fluctuations in commodity prices, changing legislation and societal expectations, Aboriginal land claims)

SUSTAINABLE RESOURCES 11

Key Elements: Energy

By the end of this organizer, students will understand the elements, issues, and challenges related to energy generation and the use and management of energy related resources. Students will have analysed the economic, environmental, and social significance of energy resources from a personal, local, provincial, and global perspective. Students will have had the opportunity to develop an understanding of the technology associated with energy resources and to look at careers related to energy.

Vocabulary

biofuel, carbon footprint, efficiency of energy transformation, fuel cell, geothermal, greenhouse gas, hybrid, hydro, non-renewable energy source, renewable energy source

Knowledge

- economic, environmental, and social significance of energy generation and use
- processes associated with the generation and use of energy resources
- current practices related to management of energy resources
- roles of technology in energy resource industries
- career opportunities in energy related industries

Skills and Attitudes

- recognition of the need for managed energy activities (conservation)
- understanding of ways to reduce one's personal carbon footprint
- support of sustainable energy practices

Prescribed Learning Outcomes	Suggested Achievement Indicators: Energy
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
E1 analyse the environmental, social, and economic significance of energy generation and use at the local, provincial, and global levels	❑ outline how personal and societal needs, wants, beliefs, and actions may influence energy resource development and use ❑ define the term carbon footprint and explain its relevance to making choices related to energy consumption ❑ describe the social, economic, and environmental impacts of generating and transporting energy from renewable (e.g., hydro, wind, geothermal, tidal sources, biofuels) and non-renewable (e.g., petroleum, uranium, oil, gas, coal) resources ❑ describe past and present energy generation in British Columbia, Canada, and other areas of the world ❑ explain how British Columbia's geography enables the province to benefit from diverse energy sources
E2 describe the processes associated with the generation and use of energy resources	❑ define energy and power, and state the law of conservation of energy ❑ distinguish between renewable (e.g., wind, solar, geo-thermal) and non-renewable (e.g., fossil fuels, uranium) energy resources ❑ give examples of the efficiency of energy transformations (e.g., solar to electrical, thermal to electric) ❑ describe the processes of generating and using various forms of energy (e.g., electrical, thermal) from renewable and non-renewable sources (e.g., fossil fuels, uranium, solar, wind, water, biofuels)
E3 investigate current practices related to the management of sustainable energy resources	❑ list a range of energy uses in various economic sectors ❑ describe how energy is harnessed, transferred, and used in British Columbia ❑ describe the methods and benefits of energy conservation (e.g., regulation, pricing, education) ❑ describe how energy resources (e.g., electricity, coal, oil, natural gas) are transported (e.g., power lines, pipelines, rail)
E4 illustrate various roles of technology in energy resource industries	❑ describe emerging technologies in – energy generation (e.g., coal-bed methane deposits, geo-thermal) – energy distribution (e.g., microwave transmission, hydrogen fuelling stations) – energy consumption (e.g., hydrogen fuel cells, rechargeable batteries, hybrid vehicles, energy-efficient buildings and appliances)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Energy
E5 analyse challenges and opportunities faced by energy industries in British Columbia	❑ illustrate some of the challenges associated with distributing electricity (e.g., NIMBY - Not In My Backyard, public aversion to mega-projects, health concerns, visual landscapes, distance) ❑ summarize challenges and opportunities faced by energy industries (e.g., sustainable delivery and use of energy, marketplace dynamics, greenhouse gas emissions, Aboriginal and international treaties, legislation, competing producers, alternative energy sources)

SUSTAINABLE RESOURCES 11

Key Elements: Career Opportunities

By the end of this organizer, students will be aware of some of the employment opportunities in resource industries, the skills and training needed for these jobs, and the basic safety practices related to these jobs. It is intended that this organizer be integrated, as appropriate, throughout the course.

Vocabulary

resource-based career, safety practice, training

Knowledge

- career and job opportunities in resource sciences and related services
- skills and training needed to be successful in a given resource-based job
- potential employment opportunities in a variety of resource-based jobs and careers in British Columbia
- basic safety practices as they relate to a particular resource job or operation

Skills and Attitudes

- appreciation of the importance of resource-based jobs in British Columbia
- appreciation of the importance of secondary and post-secondary education related to jobs in the resource sector
- understanding of safety practices related to resource-sector jobs

Prescribed Learning Outcomes	Suggested Achievement Indicators: Career Opportunities
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
F1 research career and job opportunities in resource industries and related services	❑ list a variety of careers and jobs related to each resource science area addressed in this course ❑ describe skills and training needed to be successful in each resource-based job ❑ review potential employment opportunities in a variety of resource-based jobs and careers in British Columbia ❑ explain basic safety practices as they relate to a particular resource job or operation
It is intended that this organizer be integrated as appropriate throughout Sustainable Resources 11.	

Student Achievement

Sustainable Resources 12: Agriculture

SUSTAINABLE RESOURCES 12: AGRICULTURE

Key Elements: Agricultural Elements

By the end of this organizer, students will understand the importance and impact of agriculture on the development of British Columbia and Canada. Students will have assessed the impact of agriculture on global development and international relations and will have critiqued societal expectations and trends with respect to agricultural commodities. Students will have had the opportunity to develop an understanding of the technology associated with agriculture and to look at careers related to agriculture industries.

Vocabulary

Agricultural Land Reserve (ALR) *Act*, agricultural commodity, cash crop, communal farm, exotic animal, genetic engineering, hunter-gatherer

Knowledge

- cultural connections to agricultural practices
- the impact of agriculture on the historical development of British Columbia and Canada
- the impact of changing technologies on local and global agricultural practices
- the implications of international agreements on agricultural practices
- the effect of marketing on consumers' selection of agricultural commodities
- current trends in societal expectations for agricultural commodities
- career and occupational opportunities related to agricultural production

Skills and Attitudes

- identification of skills and interests that would enhance different occupational choices
- understanding of basic safety practices related to a particular agricultural career or commodity
- appreciation of the complexity of agricultural management
- recognition of the importance of a sustainable agricultural system

Prescribed Learning Outcomes	Suggested Achievement Indicators: Agricultural Elements
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
A1 examine the importance of agricultural resources in the development of Canada with emphasis on British Columbia	❑ compare ways in which society and local cultures direct the development of food production, processing, and preservation ❑ describe the cultural connections to agricultural practices (e.g., Aboriginal, religious communal farms) ❑ describe the background, development, implementation, and effectiveness of the *Agricultural Land Reserve* (ALR) *Act* ❑ describe the progression from hunter-gather societies to subsistence agriculture and later to cash crops in early Canada ❑ outline the impact of agriculture on the historical development of British Columbia
A2 assess the impact of agriculture on global development and international relations	❑ examine the impact of changing technologies (e.g., transportation, genetic engineering) on local and global agricultural practices ❑ discuss the implications of international agreements (e.g., NAFTA) on agricultural practices (e.g., government subsidies, quotas, marketing boards) ❑ identify examples of how political/corporate decisions (e.g., company decisions to change banana distribution from a Pacific port to an Atlantic port in Panama, and moving pineapple production from Hawaii to the Philippines) affect global economies and developing nations
A3 critique current trends in societal expectations for agricultural commodities	❑ describe the impact of changing demands for organic and other specialty commodities on agricultural production ❑ identify sources of food products found in local retail outlets ❑ outline rationales used to set standards for grading of food products ❑ describe the influences of media and marketing on agricultural trends (e.g., organic, free range, game farms, exotic animals, agri-tourism) ❑ analyse the impact of societal expectations to have specific agricultural products (e.g., grapes, nectarines) available all year round
A4 research career information and job opportunities in diverse agricultural enterprises and related services	❑ identify career clusters and the range of occupational opportunities related to the various stages of agricultural production ❑ determine the skills and interests that would enhance different occupational choices ❑ describe the basic production and business management skills related to a particular agricultural commodity ❑ explain basic safety practices as they relate to a particular agricultural career or commodity (e.g., machinery safety, pesticide safety, food safety)

SUSTAINABLE RESOURCES 12: AGRICULTURE

Key Elements: Components of Sustainable Agricultural Systems

By the end of this organizer, students will understand the concept of sustainability as it relates to agriculture. Students will be able to recognize and describe the biological and physical components of agricultural systems and state the importance of each. They will have considered the importance of water and good water management practices and undertaken an analysis of the use of land and soil management practices and the effect of these on sustainable agriculture systems. Students will recognize the roles of various forms of energy in agriculture and will have considered the roles of fertilizers, pesticides, pharmaceuticals, weather, and climate in agricultural activities and production.

Vocabulary

Agricultural Area Plan (AAP), British Columbia Soil Information System (BCSIS), dryland farming, micronutrient, pesticide, Plant Hardiness Zone, stewardship, tillage, trophic level, urbanization

Knowledge

- sustainability as it relates to agriculture
- the components of an agricultural system
- the biological and physical components of agricultural systems
- how the characteristics of a particular location affect the choice of commodity to grow
- the impact of water management practices on the sustainable production of agricultural commodities
- the effect of land and soil management practices on the sustainable production of agricultural commodities
- the roles of various forms of energy in agricultural production
- the use of water, fertilizers, pesticides, and pharmaceuticals in agricultural activities

Skills and Attitudes

- appreciation for the need for sustainable systems in agriculture
- appreciation for the need for energy conservation in agriculture
- appreciation for the need for effective water management practices

Prescribed Learning Outcomes	Suggested Achievement Indicators: Components of Sustainable Agricultural Systems
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
B1 debate the concept of sustainability as it relates to agriculture	❑ illustrate the concept of sustainable agriculture ❑ describe the impact of economic activities, urbanization, and population growth on agriculture ❑ analyse the concepts of stewardship and sustainability as they relate to agriculture ❑ outline Aboriginal beliefs regarding stewardship and sustainability as they relate to agriculture ❑ outline local and provincial steps taken to ensure agricultural sustainability
B2 investigate the components of an agricultural system	❑ describe the biological and physical components of agricultural systems, including soil, water, climate, nutrients, energy, and micro-organisms ❑ discuss the importance of water, soil, nutrients, energy, and climate in the production of an agricultural commodity ❑ discuss how the components in a particular location affect the choice of commodity to grow
B3 assess the impact of water management practices on the sustainable production of agricultural commodities	❑ discuss the role and importance of water quantity and quality in the production of agricultural commodities (e.g., irrigation and animal and plant health) ❑ explain the role of water management practices in ensuring sustainable agricultural practices (e.g., drip irrigation, night-time irrigation, dryland farming) ❑ explain the role of drought management practices in ensuring sustainable agricultural practices (e.g., crop choice, contour ploughing, cover crops) ❑ describe the results of conflicting water management practices on agricultural activities
B4 analyse the use of current land and soil management practices on the sustainable production of agricultural commodities	❑ describe a soil capability classification system (e.g., British Columbia Soil Information System [BCSIS]) ❑ identify biotic and abiotic components of soil ❑ discuss the importance of soil in the production of agricultural commodities ❑ discuss factors that affect soil productivity (e.g., acidity, organic matter, micro-nutrients) ❑ explain the reasons for current practices related to land use and soil maintenance ❑ compare and contrast different methods (e.g., chemical vs. organic fertilizers, conventional vs. low tillage) of sustaining soil quality (e.g., fertility, structure) ❑ outline a local agricultural area plan (AAP) or other local land and soil management practices

Prescribed Learning Outcomes	Suggested Achievement Indicators: Components of Sustainable Agricultural Systems
B5 evaluate the roles of various forms of energy in agricultural production	❑ outline the role of energy in the production of agricultural commodities ❑ identify ways in which renewable and non-renewable forms of energy are currently used in agriculture ❑ discuss the flow of energy through trophic levels (e.g., more energy is required to produce a kilogram of animal tissue than a kilogram of plant tissue) ❑ investigate ways to increase energy efficiency in agriculture
B6 analyse the use of water, fertilizers, pesticides, and pharmaceuticals in agricultural activities	❑ determine the effect of using different waste water management strategies ❑ discuss the use of commercially produced fertilizers, pesticides, and pharmaceuticals on the production of agricultural commodities ❑ compare how organically produced commodities address the issues of fertility, pest control, and weed control
B7 investigate the role of climate in agricultural production	❑ identify agricultural practices (e.g., dryland farming techniques) resulting from climate conditions (e.g., drought) ❑ list climatic requirements for specific agricultural commodities (e.g., plant hardiness zone guide) ❑ describe how changing climatic conditions influence crop choice ❑ analyse how crops produced in different parts of BC might be affected by climate change ❑ analyse the effects weather (e.g., frost, hail, severe weather, precipitation) has on agricultural production (e.g., damaged crops, improved quality of ice-wine grapes)

SUSTAINABLE RESOURCES 12: AGRICULTURE

Key Elements: Agricultural Commodities

By the end of this organizer, students will be able to identify the organisms involved in local agriculture and outline their structures, roles, and physiological processes. Students will be able to explain the importance of animal care and management practices in agriculture. Students will be able to describe the effect of technology on the production of agricultural commodities.

Vocabulary

artificial insemination, cloning, feeding regime, feedlot, forage, fruit, genetic alteration, grain, herbicide, hybrid, selective breeding, slow-release fertilizer, vegetable

Knowledge

- use of specific organisms involved in local agriculture
- structures, roles, and physiological processes of various organisms in agriculture
- importance of animal care and management in agriculture
- effects of technology on the production of agricultural commodities

Skills and Attitudes

- understanding of the complexity of agricultural systems
- support of sustainable management practices related to organisms, land, soil, and water
- understanding of the safe use of agricultural technologies

Prescribed Learning Outcomes	Suggested Achievement Indicators: Agricultural Commodities
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
C1 identify specific agricultural organisms and associated commodities	❑ identify organisms (e.g., fungi, plants, mammals, birds, insects, fish) produced and used in agriculture ❑ identify commodities produced from agricultural organisms ❑ describe organisms that British Columbia Aboriginal peoples managed and harvested
C2 outline the structures, roles, and physiological processes of various organisms used in agriculture	❑ describe the structures of plants (e.g., roots, stems, leaves, flowers, fruits, seeds) and animals (e.g., hide, meat, bones, organs) used in agriculture ❑ describe the roles of plants (e.g., production of forage, grain, fruit vegetables, fuel) and animals (e.g., meat production, fibre, recreation, labour) used in agriculture ❑ relate the physiological processes of growth, maintenance, and reproduction (e.g., photosynthesis, digestion, respiration, transpiration, pollination, disease resistance) to agricultural commodities
C3 assess the importance of animal care and management in agriculture	❑ analyse animal needs (e.g., feeding, shelter, water, husbandry) ❑ analyse various methods of improving and increasing animal production (e.g., artificial insemination, diet) ❑ describe a variety of beneficial animal health practices (e.g., vaccinations, de-worming, de-horning)
C4 analyse the effect of agricultural practices and technology on the production of plants and animals	❑ describe technology used to – improve yield (e.g., fertilizers, tillage, plant breeding) – increase available nutrients (e.g., feeding regimes, slow release fertilizers) – increase resistance to disease (e.g., vaccination, genetic alteration) – improve the control of pests (e.g., herbicides, pheromones) – develop new varieties of agricultural organisms (e.g., selective breeding, hybrids, clones) – explore effects of genetic alteration on plant and animal production ❑ explain how the use of technologies (e.g., greenhouses, hydroponics) impacts the production of agricultural commodities ❑ explain how the use of technologies (e.g., preservation techniques, cloning, feedlots) has impacted the cost to consumers of various food products

SUSTAINABLE RESOURCES 12: AGRICULTURE

Key Elements: Agricultural Supports and Challenges

By the end of this organizer, students will be able to assess the effects of policies and practices on agriculture. Students will be able to analyse local practices related to agricultural production and describe challenges related to the safe and efficient production, handling, and distribution of agricultural commodities.

Vocabulary

Agricultural Area Plan (AAP), Agricultural Land Reserve (ALR), genetically modified organism (GMO), migrant worker, organic, patent, quota, subsidy, urban sprawl

Knowledge

- effects of policies and practices on agriculture
- local practices related to agricultural production
- history of local practices related to agricultural activities
- local and provincial land development issues as they pertain to the concepts of stewardship and sustainability
- challenges related to the safe and efficient production, handling, and distribution of agricultural commodities
- environmental issues as they relate to agricultural practices
- effect of agricultural activities on water quality and quantity

Skills and Attitudes

- understanding of efficient energy use when engaging in agricultural activities
- understanding of effective water use and management
- appreciation of the role and consequences of agriculture-related policies

Prescribed Learning Outcomes	Suggested Achievement Indicators: Agricultural Supports and Challenges
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
D1 assess the effects of policies and practices on agriculture	❑ identify key local and provincial land development issues as they pertain to the concepts of stewardship and sustainability (e.g., Agricultural Land Reserve, Agricultural Area Plan, hydroelectric water reservoirs, land claims, urban sprawl, conservation of natural environments) ❑ describe the impact on agricultural activity resulting from policies related to economic activity (e.g., taxes, subsidies, quotas, patents) and land use (e.g., urbanization, treaties, tourism)
D2 analyse local practices related to agricultural production	❑ identify the history of local practices related to agricultural activities (e.g., Aboriginal, early settlers, immigrant workers) ❑ compare and contrast local practices related to agricultural activities (e.g., current practices, cultural influences, Aboriginal, early settlers, immigrant workers) ❑ describe the infrastructure required to effectively support agriculture
D3 examine challenges related to the safe and efficient production, handling, and distribution of agricultural commodities	❑ identify challenges (e.g., fuel costs, spoilage, stress to animals) in moving agricultural products from producer to consumer ❑ describe challenges (e.g., maintain freshness, availability, appearance) and solutions (e.g., produced locally, organic) that result from consumer demands ❑ review the basic marketing strategies related to a particular agricultural commodity ❑ describe standards for the safe handling of commodities
D4 discuss environmental issues as they relate to agricultural practices	❑ describe the effect of agricultural activities on water quality and quantity (e.g., agricultural runoff may be contaminated) ❑ identify greenhouse gas emissions and pollution resulting from agricultural activities ❑ describe effects of genetically modified organisms on gene pools

Student Achievement

Sustainable Resources 12: Fisheries

SUSTAINABLE RESOURCES 12: FISHERIES

Key Elements: Fishery Resources and Society

By the end of this organizer, students will recognize the importance of fisheries and the impact of fishing and ocean resources on global development and international relations. Students will also recognize the relationship between fisheries and the development of British Columbia. Students will also have analysed present and future employment opportunities in fisheries.

Vocabulary

fisheries, Pacific Salmon Treaty, resource

Knowledge

- importance of fisheries in British Columbia and Canada
- impact of fishing and ocean resources on global development and international relations
- relationship between fisheries and the development of British Columbia
- present and future employment opportunities in fisheries
- safety issues within the fishing industry
- current fisheries in British Columbia and the environmental, cultural, and economic factors that support them
- challenges in fishing and enforcement of regulations
- challenges related to stewardship of shared ocean resources

Skills and Attitudes

- appreciation of the complexity of fisheries interests
- ability to conduct research related to careers and job opportunities in fisheries and related services
- understanding of basic safety as it relates to fishery activities

Prescribed Learning Outcomes	Suggested Achievement Indicators: Fishery Resources and Society
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
A1 assess the importance of fisheries in British Columbia and Canada	❑ define fisheries as activities and processes related to aquatic species (both fresh and salt water) with culturing and/or harvesting potential (commercial and recreational) ❑ examine the impact of current fisheries on employment and the economy within Canada and British Columbia ❑ discuss changes in fisheries in Canada and British Columbia (e.g., commercial whaling, the rise and fall of the East Coast cod fishery, salmon licence buy-back programs) ❑ identify the role aquatic species play in a healthy human diet ❑ discuss the roles of aquatic species in Aboriginal cultures (e.g., food, social, and ceremonial needs)
A2 analyse the impact of fishing and ocean resources on global development and international relations	❑ discuss the ocean as an internationally shared resource ❑ summarize international agreements (e.g., Pacific Salmon Treaty) related to fishing off the coast of British Columbia ❑ discuss the importance of international relations and international treaties and agreements to ocean resources ❑ outline challenges in fishing and enforcement of regulations ❑ debate issues related to stewardship of shared ocean resources
A3 examine the relationship between fisheries and the development of British Columbia	❑ illustrate the changing importance of given fisheries (e.g., the decline in salmon production with a concurrent increase in tuna or sea cucumber production) that has occurred in British Columbia ❑ outline cultural, economic, and environmental factors that have led to the development and succession of fisheries ❑ examine current fisheries in British Columbia and the environmental, cultural, and economic factors that support them ❑ describe the impact of fisheries on the settlement pattern of British Columbia
A4 research career information and job opportunities in fisheries and related services	❑ list a variety of careers and jobs related to fisheries ❑ describe skills and training needed in various fishery jobs ❑ report on the potential opportunities in a variety of fishery and related services jobs and careers in British Columbia ❑ explain basic safety practices as they relate to a particular fishery commodity or activity

SUSTAINABLE RESOURCES 12: FISHERIES

Key Elements: Structure and Function of Aquatic Ecosystems

By the end of this organizer, students will be familiar with the biotic and abiotic components of a variety of aquatic ecosystems and the interactions found within aquatic ecosystems.

Vocabulary

abiotic, algae, benthic, biota, biotic, extremophile, intertidal, invasive species, invertebrate, reef, salinity, symbiosis, trawl, trophic level, turbidity, up-welling, vertebrate

Knowledge

- biotic and abiotic components of a variety of aquatic ecosystems
- interactions found within aquatic ecosystems

Skills and Attitudes

- recognition of the detrimental effect invasive species may have on aquatic ecosystems
- appreciation of the diversity of aquatic ecosystems

Prescribed Learning Outcomes	Suggested Achievement Indicators: Structure and Function of Aquatic Ecosystems
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
B1 examine the biotic and abiotic components of a variety of aquatic ecosystems	❑ describe abiotic features of salt water and fresh water ecosystems, including salinity, nutrients, tides, current, up-welling and nutrient distribution, temperature, turbidity, and substrate ❑ describe biotic features of salt water and fresh water ecosystems including anatomy and physiology of fisheries species (e.g., algae, invertebrates, fish, mammals), life cycles of fishery species, and diseases affecting fishery species ❑ identify biota in a variety of aquatic habitats, ecosystems, local waters (e.g., reef, intertidal, benthic, deep water, lake, river) ❑ describe adaptation of biota to diverse aquatic ecosystems (e.g., Lake Baikal's fresh water seals, jelly fish in symbiosis with algae, extremophiles within cave waterways, extremophiles in hot vent and cold seep environments)
B2 investigate interactions found within aquatic ecosystems	❑ describe – a variety of food webs found in aquatic ecosystems – energy flows through aquatic trophic levels – a variety of organism interactions found in an aquatic ecosystem (e.g., symbioses, competition, predation) – habitats of a variety of local fisheries species – factors affecting survival and growth of fisheries species – cycles found in an aquatic ecosystem (e.g., diurnal, seasonal, phosphorous, tidal) – the impact of disturbance (e.g., bottom trawl, oil spill, seasonal flooding, turbidity current, dams) on an aquatic ecosystem ❑ illustrate the impact of an invasive species (e.g., Eurasian milfoil, Atlantic salmon, zebra mussel, bass) on an aquatic ecosystem ❑ describe the impact of different types of fishing on aquatic habitats and population dynamics (e.g., impact of fishing herring on SARA-listed cetaceans)

SUSTAINABLE RESOURCES 12: FISHERIES

Key Elements: Sustainable Fishery Operation and Management

By the end of this organizer, students will have examined methods of assessing fishery stocks and practices related to the management of different fisheries. Students will be able to describe methods of producing cultured stocks and harvesting a variety of fishery stocks.

Vocabulary

angling, genetic alteration, intertidal, otolith, polyploid, sub-tidal, trawl, troll

Knowledge

- methods of assessing fishery stocks
- harvesting methods associated with wild stocks found in various aquatic environments
- methods used to produce cultured stock and the environmental conditions needed for different species
- management practices (tools and strategies) related to sustainable fisheries

Skills and Attitudes

- recognition of the need for management of fisheries to sustain stocks
- recognition of the need to address multiple perspectives when managing sustainable fisheries

Prescribed Learning Outcomes	Suggested Achievement Indicators: Sustainable Fishery Operation and Management
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
C1 examine methods of assessing fishery stocks	❑ explain why population assessment is important (e.g., to assist in setting quotas, evaluate enhancement programs, support fisheries sustainability) ❑ explain procedures (e.g., tagging, trapping, direct counts, otolith aging) used to assess local fish populations (e.g., size, population, health) ❑ describe methods (e.g., interpreting statistical data, computer modelling) used to evaluate stocks
C2 describe harvesting methods associated with wild stock	❑ identify common harvesting methods (e.g., trolling, trawling, netting, diving, spearing, angling, trapping) associated with different fisheries (i.e., commercial and recreational) including – off-shore (e.g., squid, tuna, sablefish) – sub tidal (e.g., salmon, herring, crab, krill, shrimp, kelp) – intertidal (e.g., seaweed, oyster, clam, mussels) – fresh water (e.g., trout, salmon, sturgeon) ❑ compare traditional and current Aboriginal harvesting methods
C3 describe methods used to produce cultured stock	❑ identify and describe organisms raised through aquaculture ❑ describe the optimal environment for a cultured species ❑ outline conditions for aquaculture operations (e.g., species selection, location, waste management, accessibility, security, market)
C4 assess management practices related to different fisheries	❑ identify stakeholders in fisheries management in British Columbia ❑ explain multiple perspectives that influence a fisheries or aquaculture-related decision or issue ❑ summarize local regulations related to fisheries ❑ outline national and international regulations related to fisheries ❑ outline methods used to monitor catches and by-catches ❑ list strategies (e.g., population modelling) and tools (e.g., legislation, quota) used to manage fisheries ❑ describe how management decisions are influenced by sustainability concerns
C5 investigate technologies used in fisheries	❑ describe current research and technologies (e.g., depth-sounder, GPS) used to locate, monitor, and harvest fisheries species ❑ describe recent technological changes in fisheries practices ❑ describe research and technology related to enhancement practices (e.g., polyploids, hatcheries and stocking, genetic alterations) ❑ describe research and technology related to aquaculture practices (e.g., genetic enhancement of stock, closed-pen and open-pen containment, diet)

SUSTAINABLE RESOURCES 12: FISHERIES

Key Elements: Fishery Products

By the end of this organizer, students will have investigated the local, provincial, national, and global marketplace for fishery products and considered the economic benefits derived from these products. Students will have analysed how a variety of fishery products are made and investigated the related technology and research.

Vocabulary

biota

Knowledge

- economic benefits derived from fishery products
- how a variety of fishery products are made
- local, provincial, national, and global marketplace for fishery products
- technology and research related to fishery products

Skills and Attitudes

- investigation of product developments
- identification of current fishery product innovation
- appreciation of the diversity of fishery products and markets

Prescribed Learning Outcomes	Suggested Achievement Indicators: Fishery Products
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
D1 examine the economic benefits derived from fishery products	❑ summarize the range of consumer products and services derived from fisheries (e.g., food, meal, fertilizer, tourism) ❑ describe the economic importance of wild and cultured products derived from fisheries ❑ outline the production and marketing of consumer products and services derived from fisheries
D2 describe how a variety of fishery products are made	❑ describe the production of a variety of fisheries products (e.g., fillets, fish meal, fertilizer, pharmaceuticals, krill oil, nutritional supplements, spa products) ❑ outline the use of energy in various aspects of fisheries and fishery-related industries
D3 investigate the local, provincial, national, and global marketplace for fishery products	❑ list end uses of a variety of BC fishery products ❑ identify the commercial potential of local biota ❑ summarize relevant details about the consumer markets (e.g., USA, China, Japan, Europe, Canada, BC) that buy BC fishery products ❑ describe emerging marketplaces for BC fishery products ❑ outline possible roles of consumers in affecting fishery policies (e.g., not buying a specific product)
D4 investigate technology and research related to fishery products	❑ describe an example of how technology (e.g., factory ships, aquaculture, drying ovens, smoke houses) is used in the production of fishery products ❑ report on current innovations in fishery product development ❑ identify research related to new product development (e.g., pharmaceuticals, dietary supplements, fabrics containing seaweed)

SUSTAINABLE RESOURCES 12: FISHERIES

Key Elements: Issues and Challenges Facing Sustainable Fisheries

By the end of this organizer, students will have determined the economic, political, environmental, and sustainability issues and challenges related to sustainable fisheries. Students will also have assessed the issues and challenges related to aquaculture.

Vocabulary

el Niño, la Niña

Knowledge

- environmental issues and challenges related to sustainable fisheries
- types of pollution that impact sustainable fisheries
- impact of dry-land operations on aquatic habitats
- economic issues and challenges related to sustainable fisheries
- political issues and challenges related to sustainable fisheries
- conflicting demands on fresh water resources

Skills and Attitudes

- appreciation of the conflicting demands on fisheries and fishery resources

Prescribed Learning Outcomes	Suggested Achievement Indicators: Issues and Challenges Facing Sustainable Fisheries
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
E1 determine environmental issues and challenges related to fisheries	❑ list types of pollution that impact fisheries (e.g., bioaccumulation, toxins, chemical, thermal, sonic) ❑ discuss how dry-land operations (e.g., mining, forestry, urbanization, agriculture) impact aquatic habitats ❑ discuss how global environmental changes (e.g., greenhouse gases, el Niño/la Niña) impact fisheries
E2 outline economic and political issues and challenges related to fisheries	❑ list economic issues that impact fisheries (e.g., increased production costs, market fluctuations, competition, consumer demand) ❑ list political issues that impact fisheries (e.g., taxes, international agreements, Aboriginal treaties, licence buy-back programs, moratoria) ❑ discuss how changing costs (e.g., energy, labour) play a role in the viability of fisheries ❑ discuss how economic issues (e.g., the changing value of the Canadian dollar) impact various fisheries (e.g., commercial, recreational) ❑ describe how economic pressures influence scales of production
E3 analyse sustainability issues and challenges related to fisheries	❑ list sustainability issues that impact fisheries (e.g., over harvesting, predation, habitat degradation, stakeholder issues) ❑ outline conflicting demands (e.g., irrigation, flood control, dams, industrial effluent) on fresh water resources ❑ describe commercial, recreational, and ceremonial pressures on local fish populations ❑ describe the challenges in modelling and forecasting fisheries stock
E4 assess issues and challenges related to aquaculture	❑ debate the use of open-pen vs. closed-pen containment systems ❑ identify the effects of giving cultured populations food enhanced with medications and hormones ❑ discuss impacts (e.g., transfer of parasites, disease) resulting from contact between cultured and wild species ❑ describe possible environmental impacts (e.g., pollution, species invasion) resulting from aquaculture ❑ identify impacts of public perceptions on aquaculture (e.g., aesthetic values, wild vs. farmed salmon)

Student Achievement

Sustainable Resources 12: Forestry

SUSTAINABLE RESOURCES 12: FORESTRY

Key Elements: Forest Resources and Society

By the end of this organizer, students will be able to explain the importance of forest resources to British Columbia and Canada. Students will have reported on the distribution of different types of forests found in Canada, with an emphasis on those found in British Columbia, and analysed management needs and practices related to forest resources.

Vocabulary

biogeoclimatic zone, forest, forestry, forest resources, integrated resource management, licence, sustained yield, tenure, woodlot

Knowledge

- importance of forest resources to British Columbia and Canada
- roles of stakeholders in setting forest policy
- variety of forest resources
- distribution of different types of forests found in Canada, with emphasis on British Columbia
- management needs and practices related to forest resources
- current forest management practices
- integrated resource management

Skills and Attitudes

- demonstration of planning principles needed to develop a sustainable integrated resource management plan
- description of a plan for integrated resource management
- appreciation of the views and values of different forest stakeholders

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forest Resources and Society
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
A1 assess the importance of forest resources to British Columbia and Canada	❑ define the terms resource, forest, and forestry ❑ list a variety of forest resources (e.g., trees, plants, animals, soil, water) ❑ describe the relationship between society and forests (e.g., how changing public expectations influence policy development) ❑ identify impacts of forests and forest industries on the local and provincial economy ❑ describe the importance of forests to Aboriginal peoples ❑ outline the conflicting societal expectations (e.g., land claims, agriculture vs. forestry, recreation) on forest resources ❑ compare past and present forestry practices and resource uses in British Columbia
A2 report on the distribution of different types of forests found in Canada, with emphasis on British Columbia	❑ identify factors that determine the type and distribution of forests in British Columbia and Canada ❑ locate and describe the forest regions of Canada with an emphasis on British Columbia's biogeoclimatic zones ❑ describe common tree species that grow in specific regions of Canada and British Columbia
A3 examine management needs and practices related to forest resources	❑ define the terms *integrated resource management* and *sustained yield* ❑ illustrate different types of forest use ❑ describe different forest stakeholders (e.g., recreation, agriculture, mining, forestry, conservation) and their views and values ❑ explain the planning principles used to develop an integrated resource management plan
A4 analyse current forest management practices	❑ explain goals of British Columbia forest management programs ❑ outline methods of allocating land and timber in forest management ❑ summarize regulations (e.g., *Forest and Range Practices Act* (FRPA)) governing sustainable forestry management practices ❑ describe different licences used to manage British Columbia's forested lands (e.g., woodlot, tree farm, community forest, timber sale) ❑ describe a plan for integrated resource management ❑ outline different third-party certification of sustainable forest practices (e.g., Canadian Standards Association, International Standards Organization, Forest Stewardship Council International)

SUSTAINABLE RESOURCES 12: FORESTRY

Key Elements: Forest Ecology

By the end of this organizer, students will be able to describe the structure and growth of trees and the components of a forest ecosystem, as well as the interactions found within a forest environment. Students will be able to assess the impact of environmental components and changes on a forest ecosystem.

Vocabulary

angiosperm, biodiversity, bole, carbon cycle, crown, deciduous, disturbance, ecological succession, even-aged, evergreen, gymnosperm, nitrogen cycle, photosynthesis, primary growth, respiration, root, secondary growth, stand, structural diversity, topography, transpiration, uneven-aged

Knowledge

- structure and growth of trees
- components of forest ecosystems
- interactions found within a forest environment
- impact of environmental components and changes within a forest ecosystem

Skills and Attitudes

- identification of local tree species and their habitat requirements
- identification of environmental factors that influence tree growth
- identification of types of plants, other than trees, found in forests
- appreciation of the complexity of forest ecosystems

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forest Ecology
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
B1 examine the components of forest ecosystems	❑ describe the components of a forest ecosystem, including organisms, soil, climate, topography, water, and air ❑ identify factors that determine the presence of tree species and forest ecosystems in particular environments
B2 investigate the interactions found within a forest environment	❑ define structural diversity, stand, even-aged, uneven-aged ❑ identify types of plants, other than trees, found in forests ❑ describe – a variety of food webs found in a forest – a variety of organism interactions found in a forest environment (e.g., symbioses, competition, predation) – habitat requirements of a variety of local plants – factors affecting plant survival and growth – cycles found in a forest ecosystem (e.g., nitrogen, carbon) – the processes of photosynthesis, respiration, and transpiration – roles that animals, fungi, microbes, and lichens play in a forest ecosystem
B3 assess the impact of environmental components and changes on a forest ecosystem	❑ explain ecological succession and disturbance (e.g., wildfire, disease, insects) within a forest ecosystem ❑ explain the roles of soil (e.g., water filtration, decomposition), air (e.g., transport, source of oxygen) and water (e.g., temperature regulation) in forest ecosystems ❑ describe forest biodiversity ❑ illustrate the effects of environmental changes on a forest ecosystem
B4 analyse the structure and growth of trees	❑ define the following terms: primary and secondary growth, angiosperm, gymnosperm, evergreen, deciduous ❑ describe tree structures (e.g., bole, roots, crown; cells, tissues; leaves, cones, seeds) and associated functions (e.g., transportation, storage, and support; photosynthesis, respiration, transpiration) ❑ explain the life processes of trees (e.g., transportation, storage, support, reproduction, photosynthesis, respiration, transpiration) ❑ identify a number of local tree species and their habitat requirements ❑ identify environmental factors (e.g., light, nutrients, water, pests, disease, disturbances) that influence tree growth

SUSTAINABLE RESOURCES 12: FORESTRY

Key Elements: Forest Woodland Operations

By the end of this organizer, students will be able to demonstrate the use of maps and measurement practices related to the collection and interpretation of forest data, and describe practices used in site layout and harvesting of forest resources. Students will have described a variety of technologies used in the harvesting, transportation, and processing of forest resources. Students will have examined the post-harvest practices of a managed forest and the tools and machinery used in support of safe forestry practices.

Vocabulary

annual allowable cut (AAC), clear cut, control burn, feller buncher, forest cover map, Geographic Information System (GIS), high lead cable system, orthophoto, seed tree, shelterwood, silviculture, silviculture system, site plan, site preparation, skidder (yarder)

Knowledge

- various mapping methods used in forestry operations
- measurement practices used to collect data related to forests
- practices used in site layout and harvesting of forest resources
- technology related to the harvesting, transportation and processing of forest resources
- post-harvest practices related to a managed forest
- tools and machinery used in support of safe forestry practices

Skills and Attitudes

- understanding of safe use of tools and machinery used in forestry
- understanding of basic forest measurement practices
- appreciation of the range of technologies used in forestry

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forest Woodland Operations
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
C1 examine the use of various mapping methods in forestry operations	❑ describe different types and attributes of maps (e.g., forest cover map) and aerial photographs (e.g., orthophoto) used in forestry ❑ interpret information from different types of maps and aerial photographs ❑ demonstrate basic navigation skills using a map, compass, and/or GPS technologies ❑ illustrate how maps, GIS, and aerial photographs are used in various forestry operations (e.g., harvesting, silviculture, planning)
C2 apply measurement practices to collect data related to forests	❑ describe random and systematic sampling techniques for gathering information about forest resources ❑ demonstrate basic forest measurement skills ❑ use forestry measurement practices to determine annual allowable cut (AAC)
C3 investigate practices used in site layout and harvesting of forest resources	❑ identify the key elements of a plan (e.g., site plan) designed to address all aspects of the management of a forest area ❑ explain pre-harvest practices (e.g., planning, site visits, stakeholder consultation) used in forestry ❑ outline issues related to road building and soil conservation ❑ analyse a variety of silviculture systems (e.g., clear cut, seed tree, shelterwood) and describe conditions when it is appropriate to use a specific system ❑ describe how safety and fire regulations influence harvesting operations
C4 investigate technology related to the harvesting, transportation, and processing of forestry resources	❑ identify tools and machinery (e.g., chain saws, skidders, feller bunchers, high lead logging cable systems, underwater cutters) used in forestry activities such as harvesting, transporting, and processing forestry resources ❑ describe impacts of the use of various forestry tools on the forest environment ❑ illustrate ways in which energy could be saved during forestry activities (e.g., harvesting, transporting, and processing)

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forest Woodland Operations
C5 assess the post-harvest practices of a managed forest	❑ define silviculture ❑ explain the purpose of site preparation ❑ describe tools used in site preparation activities ❑ critique current reforestation practices ❑ analyse factors related to seeds and seedling production, storage, transportation, and planting ❑ outline the objectives and various methods of stand tending (e.g., thinning, brushing, pruning, commercial spacing) ❑ describe control burns and other fire management strategies
C6 examine the tools and machinery used in support of safe forestry practices	❑ describe equipment used to help ensure personal safety ❑ identify tools and machinery used to prevent and fight forest-related fires ❑ describe safety features of machinery used in the forest industry (e.g., enclosed cabs, two-way radios)

SUSTAINABLE RESOURCES 12: FORESTRY

Key Elements: Forest Products

By the end of this organizer, students will have investigated the local, provincial, national, and global marketplace for BC forest products and the economic benefits derived from forest products. Students will be able to describe some of the technology and research related to the production of a variety of forest products.

Vocabulary

biofuel, fibre forest product, lumber, non-fibre forest product, paper, pelletization, plywood, pulp, value-added

Knowledge

- economic benefits derived from forest products
- production of a variety of forest products
- local, provincial, national, and global marketplace for forest products
- technology and research related to the production of forest products

Skills and Attitudes

- identification and description of markets for forest products
- investigation of the production and marketing of consumer products and services derived from Canada's forests
- analysis of production methods for a variety of forest products
- appreciation of the diversity of fibre and non-fibre forest products

Prescribed Learning Outcomes	Suggested Achievement Indicators: Forest Products
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
D1 examine the economic benefits derived from forest products	❑ describe the economic importance of a variety of fibre (e.g., lumber, pulp) and non-fibre products (e.g., medicinal plants, berry crops, furs, range animals) derived from British Columbia's forests ❑ describe the range of consumer products and services (e.g., access to recreational trails, campsites) derived from Canada's forests ❑ research the production and marketing of consumer products and services derived from Canada's forests
D2 investigate how a variety of forest products are made	❑ analyse the production of a variety of forest products (e.g., lumber, pulp, paper, plywood, biofuels, value added) ❑ outline the use of energy in various aspects of forestry and forestry-related industries
D3 explore the local, provincial, national, and global marketplace for forest products	❑ list end uses of a variety of BC forest products ❑ analyse the consumer markets (e.g., USA, Japan, Europe, Canada, BC) that buy BC forest products ❑ describe emerging marketplaces (e.g., India, Korea, China) for BC forest products
D4 investigate technology and research related to forest products development	❑ describe examples of how technology (e.g., X-rays, laser measuring devices, pelletization) are used in the production of forest products ❑ report on current innovations in forest product development ❑ identify research related to new product development (e.g., fibre-based concrete, pharmaceuticals, biofuels)

SUSTAINABLE RESOURCES 12: FORESTRY

Key Elements: Sustainable Forestry Opportunities and Challenges

By the end of this organizer, students will be familiar with career opportunities and safety issues and practices in the forestry sector. Students will also be familiar with current local and global issues in forest management, and the challenges impacting the health and sustainability of forest resources.

Vocabulary

exotic plant, Geographic Information System (GIS), millwright, Mountain Pine Beetle, Registered Forest Technologist (RFT), Registered Professional Forester (RPF), rust, Softwood Lumber Agreement, urbanization

Knowledge

- career information and job opportunities in the forestry sector
- current local and global issues in forest management
- challenges impacting the health and sustainability of forest resources in British Columbia

Skills and Attitudes

- demonstration and support of actions that foster the sustainability of forests
- understanding of safe practices in forestry-related activities
- analysis of the impact of conflicting land use requirements on forest sustainability
- appreciation of the range of job opportunities associated with forests

Prescribed Learning Outcomes	Suggested Achievement Indicators: Sustainable Forestry Opportunities and Challenges
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
E1 investigate career information and job opportunities in the forestry sector	❑ identify career opportunities in – forest resource management (e.g., Registered Professional Forester, conservation officer, wildlife biologist, Registered Forest Technologist, GIS technician) – harvesting operations (e.g., equipment operator, mechanic) – silviculture (e.g., tree planter, brush saw operator, surveyor) – research, development, and marketing of forest products (e.g., fibre scientist, wood broker) – manufacturing (e.g., saw mill worker, millwright, engineer) ❑ describe the skills and training required for various forest careers ❑ report on the potential opportunities in a variety of forestry jobs and careers in British Columbia
E2 analyse current local and global issues in forest management	❑ compare and contrast issues and trends involving Canada's forests with similar issues and trends in other parts of the world ❑ identify economic factors (e.g., mill closures, housing construction, carbon credits, recreation, aesthetics, Softwood Lumber Agreement, forest health, forest fires) affecting forest industries and communities ❑ outline actions that foster the sustainability of forests
E3 analyse safety practices related to the forest industry	❑ describe common forest safety issues faced by forest users and forestry workers ❑ outline safety training programs provided for forestry workers ❑ suggest changes and additions to current safety programs and training
E4 outline the challenges impacting the health and sustainability of forest resources in British Columbia	❑ describe impacts of weather (e.g., drought, flooding, cold) on the health of forests ❑ discuss impacts of climate change on forests in British Columbia ❑ discuss the impact of insects (e.g., Mountain Pine Beetle, gypsy moth), microbes (e.g., rusts), animals (e.g., voles, mice, deer, cattle), plants (e.g., shrubs, exotic plants) on the health of forests ❑ describe how forest management decisions are affected by insects, diseases, and disturbances ❑ explain the steps taken to manage wildlife in a forest environment ❑ discuss the impact of conflicting land use requirements (e.g., watershed management, treaties, parkland, wildlife conservation, ranching, mining, recreation, urbanization) on forest sustainability

Student Achievement

Sustainable Resources 12: Mining

SUSTAINABLE RESOURCES 12: MINING

Key Elements: Hydrocarbon and Mineral Resources in British Columbia

By the end of this organizer, students will be familiar with the relationship between resource exploration and the development of Canada with emphasis on British Columbia and the current importance of hydrocarbon and mineral resources in British Columbia and Canada. Students will have assessed the impact of mining on global development and international relations and the importance of hydrocarbon and mineral resources to Canada's position in world markets. Students will have analysed the importance of the Geological Survey of Canada, and investigated a range of career options and job opportunities in the hydrocarbon and mineral resource industries.

Vocabulary

geological, fossil fuel, hydrocarbon, mineral, mining, reclamation

Knowledge

- importance of hydrocarbon and mineral resources in British Columbia and Canada
- impact of hydrocarbon and mineral resources on global development and international relations
- development and growth of the Geological Survey of Canada
- relationship between resource exploration and the development of Canada with emphasis on British Columbia
- career information and job opportunities in hydrocarbon and mineral resource-related industries
- investment activities and opportunities in hydrocarbon and mineral resource exploration and industries

Skills and Attitudes

- recognition of the benefits and costs of hydrocarbon and mineral resource exploration and extraction in British Columbia
- recognition of the need for hydrocarbon and mineral resource exploration and extraction
- analysis of the impact of hydrocarbon and mineral resource exploration, extraction, and processing
- understanding of basic safety practices as they relate to hydrocarbon and mineral resource career

Prescribed Learning Outcomes	Suggested Achievement Indicators: Hydrocarbon and Mineral Resources in British Columbia
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
A1 examine the importance of hydrocarbon and mineral resources in British Columbia and Canada	❑ identify the relationship between mined resources and manufactured goods ❑ identify fossil fuel sources of hydrocarbons, and sources of mineral resources currently in production within British Columbia ❑ discuss the importance to the governments of Canada and British Columbia of finding and developing hydrocarbon and mineral resources ❑ examine the challenges involved in locating hydrocarbon and mineral resources ❑ explain the importance of acquiring expertise in the search for fossil fuel sources of hydrocarbons, and sources of mineral resources
A2 assess the impact of hydrocarbon and mineral exploration and extraction on global development and international relations	❑ identify regions of British Columbia that have benefited from the activities of hydrocarbon and mineral exploration and extraction industries ❑ describe the effects of hydrocarbon and mineral resource industries on a local, national, or international region (e.g., economic, social, environmental) ❑ debate the importance of hydrocarbon and mineral resource industries to the development of British Columbia and relevance to our society ❑ outline ways in which demand for hydrocarbon and mineral resources has impacted international relations
A3 analyse the development and growth of the Geological Survey of Canada	❑ discuss the development of the Geological Survey of Canada ❑ explain the role of the Geological Survey of Canada in resource exploration (e.g., regional geological mapping) ❑ explain the contribution of the Geological Survey of Canada in the development of hydrocarbon and mineral resources
A4 examine the relationship between resource exploration and the development of Canada with emphasis on British Columbia	❑ identify hydrocarbon and mineral exploration expertise and knowledge shared from Canada's Aboriginal peoples ❑ explain how the search for hydrocarbon and mineral resources contributed to the development of Canada and British Columbia ❑ describe how the development of hydrocarbon and mineral resource industries have contributed to the growth of Canada and British Columbia in world markets

Prescribed Learning Outcomes	Suggested Achievement Indicators: Hydrocarbon and Mineral Resources in British Columbia
A5 assess the importance of hydrocarbon and mineral resources to Canada's position in world markets	❑ describe the relationship between hydrocarbon and mineral resources and the development of transportation infrastructure in Canada ❑ explain the relationship between hydrocarbon and mineral resources and Canada's international activities (e.g., financial aid, international agreements, relief work) ❑ describe the importance of mineral resources and materials research in advancing technology (e.g., refractory clays make up the space shuttle tiles, magnesium as a potential substitute for aluminium)
A6 investigate career information and job opportunities in hydrocarbon and mineral resources and related industries	❑ report on the potential opportunities related to the various stages of hydrocarbon and mineral exploration, extraction, processing, and reclamation ❑ determine the skills and interests that would enhance different occupational choices ❑ explain basic safety practices as they relate to hydrocarbon and mineral resource exploration, extraction, processing, and reclamation-related careers ❑ identify areas of employment that support the hydrocarbon and mineral resource industries (e.g., stock brokers, chemical assay labs, transportation services, shipping services, machinery and equipment operators and suppliers, engineers and geoscientists, permitting and land use personnel) ❑ outline investment activities and opportunities in the mineral exploration industry including publicly held companies, stock exchanges, international investment, foreign exchange, and global commodity prices

SUSTAINABLE RESOURCES 12: MINING

Key Elements: Geology and Exploration

By the end of this organizer, students will have investigated techniques used for hydrocarbon and mineral exploration, identification, and assessment in British Columbia. Students will have outlined the processes required to claim hydrocarbon and mineral resource rights and analysed the economic investment and costs of a typical hydrocarbon or mineral resource project. Students will have assessed methods of regulating the environmental impact of hydrocarbon and mineral resource exploration, extraction, and processing.

Vocabulary

drill-hole, geochemical survey, geology, geophysical survey, off-shore drilling, seismic survey, ore

Knowledge

- techniques used for hydrocarbon and mineral exploration
- hydrocarbon and mineral deposit evaluation techniques
- techniques used for hydrocarbon and mineral identification and assessment
- identification of hydrocarbons and minerals
- formation of various sources of hydrocarbons
- formation of mineral deposits
- processes required to stake and maintain claims and rights for hydrocarbon and mineral deposits
- methods of regulating the environmental impact of hydrocarbon and mineral resource exploration, extraction, and processing industries in British Columbia
- environmental assessment process
- economic investment and costs associated with hydrocarbon and mineral resource exploration and extraction projects
- development process for a typical hydrocarbon and mineral resource exploration and extraction operation

Skills and Attitudes

- recognition of the need to preserve the environment and consult stakeholders regarding hydrocarbon and mineral resource exploration, extraction, and processing
- recognition that hydrocarbons and minerals are non-renewable resources

Prescribed Learning Outcomes	Suggested Achievement Indicators: Geology and Exploration
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
B1 investigate techniques used for hydrocarbon and mineral exploration in British Columbia	❑ describe the early stages of hydrocarbon and mineral exploration techniques including prospecting remote sensing, geophysical surveys, geochemical surveys ❑ describe the advanced stages of hydrocarbon and mineral exploration techniques, including ground geophysics, geological and geochemical studies, drilling programs, and drill-hole geophysical surveys ❑ describe hydrocarbon and metallic and non-metallic mineral deposit evaluation techniques (e.g., bulk sampling, mineral inventory, estimation of ore reserves from drill-hole data, underground exploration, seismic surveys, 3D modelling)
B2 examine techniques used for hydrocarbon and mineral identification and assessment	❑ describe the properties of hydrocarbons and minerals extracted in British Columbia ❑ describe how various fossil fuel sources of hydrocarbons are formed ❑ describe how mineral deposits form ❑ explain how various hydrocarbons and minerals are identified ❑ explain how the quality of hydrocarbons and mineral deposits are determined
B3 outline the processes required to claim hydrocarbon and mineral rights	❑ identify how hydrocarbon (e.g., oil and gas) and mineral claims are staked, filed, and processed in conjunction with government regulatory organizations ❑ describe how exploration and hydrocarbon (e.g., oil and gas) and mineral resource rights are established and the requirements to maintain them ❑ summarize regulations related to hydrocarbon and mineral resource exploration on private and public lands
B4 assess methods of regulating the environmental impact of hydrocarbon and mineral resource exploration, extraction, and processing in British Columbia	❑ describe how environmental assessments are conducted ❑ debate the regulations governing the planning of a hydrocarbon or mineral extraction operation ❑ debate regulations related to specific hydrocarbon or mineral extraction activities (e.g., underwater resources, offshore drilling, uranium exploration)
B5 analyse the economic investment and costs needed for a hydrocarbon or mineral extraction project	❑ describe the development process for a typical hydrocarbon or mineral extraction operation ❑ outline the time, monetary, and energy investments needed as a project advances through – the exploration and evaluation stages – the extraction or mine development stage – the hydrocarbon or mineral production stage – the site reclamation stage ❑ identify the various costs incurred for the development of a hydrocarbon or mineral extraction operation

SUSTAINABLE RESOURCES 12: MINING

Key Elements: Extraction and Processing

By the end of this organizer, students will have analysed the processes related to planning and designing hydrocarbon and mineral extraction facilities and associated industrial sites. Students will also have investigated methods of extracting and processing hydrocarbon and mineral resources, and compared and contrasted the financial, environmental, and social risks and benefits of surface and subsurface mining methods.

Vocabulary

coal-bed methane recovery, concentrating, cracking, drift, hard rock, open pit mine, placer mine, quarry, refining, reservoir, shaft, smelting, soft rock, strip mine, vein

Knowledge

- processes related to planning and designing hydrocarbon or mineral extraction facilities and associated industrial sites
- surface mining methods
- subsurface extraction methods
- methods of processing hydrocarbons and mineral resources

Skills and Attitudes

- understanding of the importance of regulations governing different aspects of hydrocarbon or mineral resource industries
- recognition of the importance of hydrocarbon or mineral exploration, extraction, and processing
- understanding of the environmental and social risks associated with the operation of a hydrocarbon or mineral extraction operation

Prescribed Learning Outcomes	Suggested Achievement Indicators: Extraction and Processing
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
C1 analyse processes related to planning and designing hydrocarbon or mineral extraction facilities and associated industrial sites	❑ describe steps to plan a site for a hydrocarbon or mineral extraction operation ❑ describe the stages of approval required for a particular hydrocarbon or mineral extraction plant to begin production ❑ explain the process of conducting a feasibility assessment for a hydrocarbon or mineral extraction operation
C2 compare and contrast surface mining methods, including financial, environmental, and social risks and benefits	❑ outline the process of extracting minerals from an open pit mine, quarry, strip mine, or placer mine ❑ identify when each type of surface mining might be appropriate ❑ describe the benefits and challenges of – open-pit mining – quarrying – strip mining – placer mining ❑ explain the costs (e.g., labour, energy, technology, environment, safety) associated with operating an open pit mine, quarry, strip mine, and placer mine ❑ describe the personal and environmental and social risks associated with the operation of an open pit mine, quarry, strip mine, and placer mine
C3 describe subsurface extraction methods for hydrocarbons and minerals, including associated costs, risks, and benefits	❑ describe the benefits and challenges of subsurface extraction methods for hydrocarbons and minerals, including – coal-bed methane recovery methods – soft rock underground coal mining – hard rock subsurface mining (e.g., drift, shaft, narrow vein, bulk underground mining, use of robotics) – the use of steam injection, robotics, high pressure water jets ❑ identify when and where each type of subsurface mining might be appropriate ❑ outline the process and associated technology used for extracting minerals from a hard rock mine ❑ outline the process and associated technology used for extracting hydrocarbons from a reservoir ❑ describe the costs (e.g., labour, energy, technology, environment, safety) and risks (e.g., environment, safety) associated with extracting minerals by means of different hard rock mining methods

Prescribed Learning Outcomes	Suggested Achievement Indicators: Extraction and Processing
C4 investigate methods of processing hydrocarbon and mineral resources	❑ outline methods of processing hydrocarbons (e.g., refining, cracking) ❑ describe methods of processing mined resources, including – screening – concentrating (e.g., froth flotation, gravity separation, magnetic separation, electroplating) – smelting

SUSTAINABLE RESOURCES 12: MINING

Key Elements: Sustainability and Environmental Issues

By the end of this organizer, students will have evaluated the environmental assessment processes conducted during the design and construction of hydrocarbon and mineral extraction and processing facilities. Students will also have assessed the processes of site reclamation after extraction operations are completed, and assessed the sustainability of hydrocarbon and mineral resources.

Vocabulary

consumption, non-renewable resource, renewable resource

Knowledge

- environmental assessment processes conducted during the design and construction of hydrocarbon and mineral extraction and processing facilities
- environmental concerns related to the development of a hydrocarbon or mineral extraction operation
- processes of site reclamation after hydrocarbon and mineral extraction operations are completed
- ways in which hydrocarbon and mineral extraction operations can be more energy efficient
- future of hydrocarbon and mineral resource industries

Skills and Attitudes

- analysis of the site reclamation process
- appreciation of the relationship between resource consumption and sustainability

Prescribed Learning Outcomes	Suggested Achievement Indicators: Sustainability and Environmental Issues
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
D1 evaluate the environmental assessment processes conducted for proposed hydrocarbon and mineral extraction operations and associated processing plants	❑ outline the environmental assessment process ❑ identify some of the specifications of an industrial site design ❑ describe environmental concerns related to the development of a hydrocarbon or mineral extraction operation (e.g., noise, air quality, water quality, traditional hunting and fishing) ❑ debate the environmental implications of a hydrocarbon and mineral extraction operation
D2 evaluate the processes of site reclamation during and after hydrocarbon and mineral extraction	❑ identify the requirements for site reclamation ❑ describe the monitoring process during site reclamation ❑ debate the effectiveness of current site reclamation practices ❑ compare past and present site reclamation processes
D3 assess the future of hydrocarbon and mineral resource development	❑ identify practices implemented by mining operations to become more energy efficient ❑ discuss the concept of sustainability as it relates to hydrocarbon and mineral resources ❑ analyse how choices (e.g., personal, corporate, governmental) related to hydrocarbon and mineral extraction operations are based on various factors (e.g., economic, political) ❑ discuss the relationship between consumption and sustainability ❑ discuss the global nature of the hydrocarbon and mineral resource industries ❑ debate the sustainability of the hydrocarbon and mineral extraction industries

SUSTAINABLE RESOURCES 12: MINING

Key Elements: Mining Opportunities and Challenges

By the end of this organizer, students will have assessed the development and use of new extraction and processing methods, and analysed the environmental impacts of various activities related to hydrocarbon and mineral resource extraction, processing, and use. Students will have investigated possible future activities in hydrocarbon and mineral extraction operations.

Vocabulary

acid-rock drainage, black smoker, conservation, deep ocean mining, greenhouse gas, magnesium nodule, metallurgy, methyl hydrate deposits, peak oil theory

Knowledge

- development and use of new hydrocarbon and mineral extraction and processing methods
- environmental impacts of various activities related to hydrocarbon and mineral resource extraction, processing, and use
- recycling potential of non-renewable resources
- future opportunities in mining

Skills and Attitudes

- appreciation of the challenges related to future hydrocarbon and mineral exploration

Prescribed Learning Outcomes	Suggested Achievement Indicators: Mining Opportunities and Challenges
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding Prescribed Learning Outcome.* *Students who have fully met the Prescribed Learning Outcome are able to:*
E1 assess the development and use of new extraction and processing methods	❑ describe the use of robotics in hydrocarbon and mineral extraction operations ❑ outline recent changes in hydrocarbon extraction and metallurgy ❑ explain how high water pressure can be used in mining ❑ analyse the costs, benefits, and risks of – offshore oil and gas exploration – undersea mining – mining in remote areas (e.g., mountains, arctic)
E2 analyse environmental impacts of various activities related to hydrocarbon and mineral resource extraction, processing, and use	❑ describe the impact of hydrocarbon and mineral extraction and processing operations on the environment (e.g., tailings, acid-rock drainage) ❑ explain reasons for some of the choices societies make in how they use non-renewable resources (e.g., economic dependence on fossil fuel, peak oil theory, greenhouse gas emissions, need for conservation) ❑ debate current and potential practices and associated limitations of recycling non-renewable resources
E3 investigate possible future activities in hydrocarbon and mineral extraction operations (e.g., seafloor, land fills, moon, asteroids)	❑ describe potential mining operations of methyl hydrate deposits or sea floor magnesium nodules or black smoker deposits using technology such as robotics ❑ discuss technology challenges connected with deep ocean mining ❑ explain the potential mining of unlayered asteroids compared to the mining of the layered crust of the Earth ❑ discuss the future potential of mining on the moon or Mars (e.g., helium-3 isotopes for thermonuclear reactors) ❑ describe possible technologies that might support mining in space (e.g., space elevator, space station)

GLOSSARY

Sustainable Resources 11 and 12

ABOUT THE GLOSSARY

This glossary defines selected terms used in this Integrated Resource Package as they pertain to Sustainable Resources 11 and 12. It is provided for clarity only, and is not intended to be an exhaustive list of terminology related to the topics in this curriculum.

A

acid-rock drainage

Sulphide minerals within rocks react with air and water to form acidic solutions. As the water becomes more acidic, its capacity to leach out metals and other elements, as it drains through the rock, increases.

Agricultural Area Plan (AAP)

A number of B.C. municipalities and regional districts have developed Agricultural Area Plans which identify and address local agriculture issues.

see: www.agf.gov.bc.ca/resmgmt/sf/aap/index.htm

agricultural commodity

Agricultural products for which there is a consumer demand.

Agricultural Land Reserve (ALR)

In response to substantial loss of agricultural land to other uses, the Provincial Government passed the *Land Commission Act* on April 18, 1973. A result of this Act was the creation of the Agricultural Land Reserve (ALR). The ALR covers approximately 4.7 million hectares (about 5% of the provincial land base). It includes private and public lands that may be farmed, forested, or vacant land. Some ALR blocks cover thousands of hectares while others are small pockets of only a few hectares. Although some boundaries have changed, the ALR remains approximately the same size.

see: www.qp.gov.bc.ca/statreg/stat/A/02036_01.htm

angiosperm

A plant that reproduces by flowers and has fruits. These are the most common land plants, and usually have broad leaves.

angling

Fishing with a hook, line, and usually a rod.

annual allowable cut (AAC)

The volume of timber harvest permitted each year from a specified area of land. AAC is set by the Chief Forester of BC and is calculated with the concept of sustained yield as its guiding principle.

aquaculture

Farming of fish, shellfish, and aquatic plants in fresh or salt water. Products are grown in ponds, or in net pens in lakes or the ocean. Organisms are fed and cared for and, once they reach an appropriate size, are harvested, processed, and shipped to market.

B

biodiversity

The variety of living things in an area. Biodiversity is affected by variety within species, number of species, and variety of habitats/ecosystems. It includes changing communities that occur over time.

biofuel

Biomass or materials derived from biomass that can be used in the production of energy.

black smoker

A hydrothermal vent on the ocean floor, on or adjacent to a mid-ocean ridge. Vent fluids contain high concentrations of metals and precipitate sulphide mineral chimneys. Unique ecosystems live on and around the chimneys.

British Columbia Soil Information System (BCSIS)

BCSIS is a central database containing soil and morphological information for the province of British Columbia.

see: srmwww.gov.bc.ca/soils/provsoil/index.html

by-catch

Non-targeted organisms caught incidentally when fishing for a different target species. Includes organisms caught commercially or recreationally that are undersized, prohibited, inedible, or unsaleable.

C

carbon footprint

Measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced.

clear cut

An area where an entire stand of trees has been harvested in a single harvest operation. As a process, it is the removal of an entire stand of trees from an area of one hectare or more in a single harvesting operation.

coal-bed methane recovery

A process for producing methane from a subterranean coal bed by continuously injecting a carbon dioxide-containing gas into the coal bed and recovering displaced and desorbed methane from a recovery well.

commodity

A product used in trade or commerce. Can be sold, or processed and resold.

concentrating

A variety of methods (e.g., gravity separation, flotation separation) used to concentrate minerals or metals from ore. Part of mineral processing.

conservation

Preservation, protection, or planned management of a natural resource.

consumption

The act or process of consuming resources. The utilization of resources to satisfy perceived wants or needs, resulting in resource destruction, deterioration, or transformation.

cracking

Breaking down or processing (usually by heating) of large molecules, such as hydrocarbons, into smaller molecules. Commercially done in oil refineries.

E

efficiency of energy transformation

When energy is transformed from one form to another, the work output is always less than the energy input. Efficiency is calculated as: work output/energy input.

extirpated

A species that has been eliminated from a particular area, but still exists somewhere else.

extremophile

Organisms (mainly bacteria) that thrive in what would normally be considered extremely hostile environments (e.g., high temperature, pressure, desiccation, salinity, pH).

F

Fisheries Act

see: lois.justice.gc.ca/en/F-14/

fossil fuel

All deposits of organic material capable of being burned as fuel. Chiefly coal, oil, and gas. Formed under pressure by alteration or decomposition of plant or animal remains.

G

genetic alteration

Humans have been altering directly or indirectly, the genetic make-up of populations of agricultural organisms for millennia. These changes have been accomplished by such process as domestication, selective breeding, hybridization, cloning, and, recently, genetic engineering.

genetic engineering

The direct manipulation of an organism's genetic make-up and resultant characteristics through recombinant DNA technology. Enzymes are used to cut and recombine strands of DNA, which can then be incorporated into an organism's DNA.

genetically modified organism (GMO)

Alteration to an organism's genome by inserting, transferring, or deleting genes or other DNA sequences in order to make the organism capable of producing new substances or performing new functions.

Geological Survey of Canada

The GSC is Canada's premier agency for geoscientific information and research, with world-class expertise focussing on geoscience surveys, sustainable development of Canada's resources, environmental protection, and technology innovation.

see: gsc.nrcan.gc.ca

geophysical survey

Systematic collection of geophysical data for spatial studies. Geophysical surveys may use a great variety of sensing instruments, and data may be collected from above or below the Earth's surface or from aerial or marine platforms.

gymnosperm

A land plant that reproduces with seeds but has no flowers. They usually have needle leaves and cones.

H

hard rock

The exploration of hard, strong intact rock deposits as opposed to soft rock or sedimentary rock exploration. Hard rock exploration and mining usually refers to exploration for metal ores.

hunter-gatherer

A society in which food and other resources are gathered directly from the wild.

hybrid

A genetic cross between different species or varieties to produce organisms with new attributes.

hybrid vehicle

A vehicle that combines a conventional propulsion system with an on-board rechargeable energy storage system to achieve better fuel economy than a conventional vehicle.

hydrocarbon

Naturally occurring organic compound containing hydrogen and carbon. May be gaseous, solid, or liquid. Includes natural gas, bitumen, and petroleum.

I

integrated resource management

A holistic approach that entails the management of two or more resources. This approach integrates the values of the community into specific plans to use and sustain the resource(s) in perpetuity.

M

maximum sustainable yield

The largest long-term average catch or yield that can be taken from a stock under the prevailing ecological and environmental conditions without depleting that stock.

methyl hydrate deposit

A frozen natural gas deposit, also known as a methane hydrate deposit. An ice-like crystalline mineral in which hydrocarbon gases are held within rigid cages of water molecules. If you put a match to methyl hydrate crystals, they burn.

mineral

A naturally occurring, inorganic, solid substance with a crystalline structure and characteristic chemical composition.

N

North American Free Trade Agreement (NAFTA)

A free-trade agreement signed in 1994 by Canada, Mexico and the United Sates of America.

see: www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/nafta-alena/index.aspx?lang=en&menu_id=1&menu=

non-renewable energy source

Refers to energy taken from finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve.

non-renewable resource

A resource that is concentrated or formed at a rate that is much slower than its rate of consumption and is non-renewable for all practical purposes.

O

old growth

Old-growth forests contain trees of various ages and species, including over-mature and dead trees. Old growth varies significantly by forest type and from one biogeoclimatic zone to another. It is generally defined as forests more that 250 years old in all Coast region forests; Interior forests dominated by lodgepole pine; deciduous species more than 120 years old; and, all other Interior forests more than 140 years old.

ore

A mineral or rock that has economic value.

organic

In agriculture "organic" refers to products produced by methods which exclude the use of synthetic fertilizers and pesticides, growth regulators, feed additives, and GMOs. Methods such as composting, mechanical tilling, and biological pest control are used to maintain agricultural systems.

P

Pacific Salmon Treaty

see: www.psc.org/publications_psctreaty.htm

peak oil theory

Peak oil is the point in time when the maximum rate of global petroleum production is reached, after which the rate of production enters a terminal decline.

Plant Hardiness Zone

A geographic zone in which specific plants are capable of withstanding the minimum temperature of the zone.

R

reclamation

The act or process of reclaiming as in rehabilitation or restoration to former use.

renewable energy source

Refers to the effective use of natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are naturally replenished to produce energy.

renewable resource

A resource produced by the functioning of a natural system at rates comparable with its rate of consumption.

S

salmonid

Organisms belonging to the family Salmonidae, including salmon and trout. These are soft-finned fishes from cold and temperate waters that usually migrate from salt water to fresh water to spawn (e.g., sockeye, chum, Coho, pink, Chinook salmon; cutthroat and steelhead trout).

selective breeding

The source of male and female gametes is planned in regards to producing offspring with desired characteristics.

site plan

A comprehensive management plan for a harvesting site. It shows the geographic location of the cut block; includes management strategies; is based on regulation and stakeholder input for protecting soil, archeological sites, wildlife, riparian areas, water, recreation, access; specifies harvesting methods, reforesting and stand tending methods; and, provides timelines.

silviculture

The art, science, and practice of growing and cultivating trees in forests to meet specific objectives and values.

silvicultural systems

The harvesting, regeneration and stand-tending of a forest to achieve specified objectives. It covers activities for the entire length of a rotation of a forest. Four systems are the partial cut, seed tree, shelterwood, and clear cut.

smelting

To process ore, often with an accompanying chemical change, to separate out metal from the original rock.

soft rock

Referring to the exploration of sedimentary rock deposits as opposed to hard, strong intact rock deposits. Soft rock exploration and mining refers to exploration for sedimentary deposits such as coal, oil and gas.

Softwood Lumber Agreement (SLA)

A trade agreement with the United States that controls the amount of softwood lumber Canadian mills can sell in the United States. The SLA was reached to settle long-standing disputes over the sale of Canadian lumber in the US.

see: www.dfait-maeci.gc.ca/eicb/softwood/menu-en.asp

Species at Risk Act (SARA)

see: www.sararegistry.gc.ca/sarredirect/

sustained yield

The amount of fibre produced annually equals the amount of fibre harvested so that the harvesting of forest resources can be sustained.

symbiosis

A close, long-lasting relationship between two species where at least one species benefits from the relationship. The other may be injured (parasitism), relatively unaffected (commensalism), or may also benefit from the relationship (mutualism).

T

tailings

Waste material from a mineral processing plant that is too poor for further processing.

topography

The shape of the land, particularly the relief and contours of the land.