Wading in for Water

Written for:

Alberta Education Programs of Study

Science 14 Unit D: Investigating Matter and Energy in the Environment

&

Environmental Stewardship (ENS) Project D

Developed and Presented by SEEDS Connections™

With support from ConocoPhillips Canada

TABLE OF CONTENTS

(Hyperlinked within the Document)

End of Science 14 Unit D

End of *Wading in for Water* Action Project (Career and Technology Studies)

ACTIVITY SHEETS: SCIENCE 14

Lesson #2 Lab Stations

Lesson #3 Aquatic Food Chains & Food Webs

Lesson #4 Jigsaw: What is industry doing to improve water recovery and water quality?

Lesson #7 Example Biotic/Abiotic Factors Example Brainstorm List

Lesson #7 Example Data Sheet

Lesson #10 Energy Pyramid Activity (Teacher Resource)

Lesson #11 Compare & Contrast Analysis

Lesson #11 Word Jumble

Lesson #12 Activity: Interactions Among Organisms (Teacher)

Lesson #12 Activity: Interactions Among Organisms (Students)

Lesson #12 Activity: Interactions Among Organisms (Game Cards I)

Lesson #12 Activity: Interactions Among Organisms (Game Cards II)

ACTIVITY SHEETS: WATER ACTION PROJECT

Lesson #5: WebQuest and Scavenger Hunt (Student)

Lesson #5: WebQuest and Scavenger Hung (Teacher Key)

Lesson #9: Personal Water Inventory (Student)

ACKNOWLEDGEMENTS

Program Module Writers

Natalie Gallant	Teacher, Queen Elizabeth High School, Calgary, AB and GREEN Schools Coordinator, SEEDS Connections ™
Jacqueline Pollard	Teacher, St. Mary's High School, Calgary, AB

Artwork

Marissa Gruenke	Design and Advertising Student, ACAD

Project Management

Hyacinth Schaeffer	Hyxpectations Educational Consulting, Calgary, AB

SEEDS Connections™ Staff

Corinne Craig	Executive Director
Steele Gibson	Strategic Project and Communications Coordinator
Zibusiso Mafaiti	Educational Project and Research Strategist
Annie Telfer	Summer Marketing, Project, and Research Assistant; Sociology Major, Mount Royal University
Lorna Wick	Secretary, Board of Directors

Teacher Reviewers

Katherine Campbell	Instructional Coach, Holy Trinity School, Fort McMurray, Alberta
Johnny Dulku	Teacher, Westwood Community High School, Fort McMurray, Alberta

INTRODUCTION

A. Overview

Welcome to *Wading in for Water*, a youth leadership module developed by SEEDS Connections™ with the support of ConocoPhillips Canada. The primary focus of this module is to provide you with an instructional guide that has direct curricular connections to all of the learning outcomes identified in Science 14, Unit D, *Investigating Matter and Energy in the Environment* (Alberta Education, 2014, https://education.alberta.ca/media/3069383/pos_science_14_24.pdf). The secondary focus is to offer opportunities for students to complete the requirements of Environmental Stewardship (ENS 3910 Project D). In order for students to receive credits for ENS 3910, they must have other Career and Technology Studies (CTS) credits. More information can be found on the Alberta Education website for ENS: (http://www.learnalberta.ca/ProgramOfStudy.aspx?lang=en&ProgramId=948119#)

This guide is designed as an instructional support resource that includes individual lesson plans, recommended resources, and suggestions for student assessment. Completing this module will address all of the student learning outcomes prescribed in the Science 14 Program of Studies for Unit D. You will find that the lessons support the development of scientific literacy through student-driven inquiry, field investigations, and class contributions to a larger database of information regarding local and provincial water quality. The foundational statements of the Science 14 Program of Studies are woven into this module taking into consideration the following:

- Science, Technology and Society (STS): Within a Social and Environmental Emphasis, students will consider the interrelationships between science knowledge, the use of technologies to better understand and monitor water quality, and the social and environmental contexts within which decisions are made about local issues.

- Knowledge: Students will develop the science knowledge within life, physical, and earth sciences that are required to understand local water issues.
- Skills: Students will develop the appropriate and relevant skills to work in the laboratory and in the field to collect and analyze water samples from the local environment.
- Attitudes: Students will be encouraged to develop attributes that can be transferred to stewardship and leadership in the school community as they contribute to a database of information that will be accessible to others involved in similar investigations.

(Alberta Education 2014, p. 3)

B. UNESCO Sustainable Development Goals: Placing Learning in a Larger Context

> *Empowering learners to live responsible lives and to address complex global challenges means that education has to promote competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way. This calls for new approaches to learning, the development of vibrant green economies and societies, and the emergence of a "global citizenship"*
>
> (UNESCO Education for Sustainable Development, retrieved from http://en.unesco.org/themes/education-sustainable-development)

UNESCO has identified seventeen (17) Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development. (https://sustainabledevelopment.un.org/?menu=1300). Among the goals are Clean Water and Sanitation (SDG 6), Life below Water (SDG 14) and Life on Land (SDG 15), all of which relate to understanding matter and energy cycling in the environment, a core component of the Science 14 program. Placing learning within the context of the SDGs encourages students to develop empathy, consider and identify local and global issues, work together to generate possible solutions using their knowledge, skills and attributes, and design prototype solutions in the form of plans, proposals or models for consideration by their peers (see Design

Thinking). Teachers are encouraged to consider using the SDGs as themes for the unit to support the social and environmental emphasis (STS).

C. Alberta Education Student Values and Standards

In 2016, Alberta Education issued a document entitled *The Guiding Framework for the Design and Development of Kindergarten to Grade 12 Provincial Curriculum (Programs of Study)*, that provides core principles that will dictate how future programs of study in all subject areas will be written (https://education.alberta.ca/media/3575996/curriculum-development-guiding-framework.pdf).

> *There are many definitions of curriculum. This document* [The Guiding Framework] *refers to provincial curriculum, also known as programs of study: "what" students are expected to know, understand and be able to do in each subject and grade. Teachers have the flexibility to determine "how" students achieve the expected learning outcomes to bring the provincial curriculum to life in the classroom through meaningful learning activities.*
>
> (Alberta Education, 2016, p. 1)

The *Wading in for Water* module acknowledges the central focus of curricular outcomes (the 'what') while providing an authentic examination of a local water environment and opportunities for students to share their data and interpretations with others (the 'how'). *The Guiding Framework* clearly denotes the following three priorities:

a) Student values or beliefs about the desirable attributes that students in Alberta schools should demonstrate. These qualities, that address engaged, ethical and entrepreneurial citizenship, include:

- Democracy and Citizenship;
- Belonging and Identity;
- Integrity and Respect;

- Perseverance and Excellence; and
- Innovation and Stewardship.

(Alberta Education, 2016, p. 3)

b) Critical competencies that should be developed across all grade levels and disciplines. These competencies are believed to contribute to the student's personal development and community involvement. The competencies identified are, in no particular order:

- Critical Thinking;
- Problem Solving;
- Managing Information;
- Creativity and Innovation;
- Communication;
- Collaboration;
- Cultural and Global Citizenship;
- Personal Growth and Well-being.

(Alberta Education, 2016, pp. 28-31)

c) Standards for Alberta Programs of Study that provide key principles upon which all curricula will be developed. There are twelve (12) standards that fall under the categories of:

- Inclusion, Accessibility and Equity;
- Multiple Perspectives and Diversity;
- Comprehensive, Developmentally Appropriate Scope and Sequence and Learning Outcomes;
- Assessments; and
- Consistent Processes for Development and Review.

(Alberta Education, 2016, pp. 23-27)

The developers of this module have taken into account the approaches, instructional strategies, and assessment options that may support development of student values, competencies, and standards

described in *The Guiding Framework.* Teachers should also pay particular attention to everyday practices that keep these attributes at the core of instruction and assessment.

D. Place-Based Education

> *Placed-based education is the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science and other subjects across the curriculum. This approach to education increases academic achievement, helps students develop stronger ties to their community, enhances students' appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens*
>
> (Sobel, 2004, p. 11).

Proponents of place-based education suggest that immersing students in the life of their communities will encourage them to take interest in and ownership of the ecological, cultural, historic, and economic viability of these places. Understanding their surroundings increases student agency to learn more and take action as they see fit. *Promise of Place* is a web site dedicated to promoting place-based education and community engagement (http://www.promiseofplace.org/what_is_pbe). It suggests that students who participate in outdoor education opportunities are more likely to:

- be more engaged and demonstrate improved academic achievement;
- develop increased links to the local community and environment; and
- search for information and contribute to solutions surrounding their local environments.

This *Wading in for Water* module has been specifically designed to address curricular outcomes (Science 14, Unit D) in such a way that students not only learn *about* the cycling of matter and energy in the environment, but through a focused investigation of a local water system they are able to make *informed contributions* to discussions and decisions surrounding water quality in their communities.

E. Design Thinking

> ***Design Thinking*** *is a mindset and approach to learning, collaboration, and problem solving. In practice, the design process is a structured framework for identifying challenges, gathering information, generating potential solutions, refining ideas, and testing solutions. Design Thinking can be flexibly implemented; serving equally well as a framework for a course design or a roadmap for an activity or group project.*
>
> *(*Retrieved from Harvard University Teaching and Learning Lab: http://tll.gse.harvard.edu/design-thinking)

Design Thinking (DT) promotes inquiry learning and distinguished by the process of taking an empathetic approach to understanding a problem, issue, or situation and taking into consideration who or what will be most impacted by the decisions or solutions proposed. Generally, there are five phases that design thinkers and innovators work through to solve problems:

a. **Discover and Empathize:** Determine what and who will be impacted by a problem or issue and consider what their needs are.
b. **Define and Interpret:** Analyze the information collected in the Discovery/Empathy phase and reframe the problem/issue into questions or statements that can be approached through inquiry and problem-solving.
c. **Ideate:** Often thought of as 'brainstorming', this phase involves divergent thinking in which individuals and groups generate possibilities and new ideas for solving the problem/issue. The key is to come up with as many ideas as possible without restrictions … those come later! A collaborative process is likely to yield a wide variety of creative, innovative ideas and approaches.
d. **Experiment and Prototype:** After choosing approaches from the ideate phase to pursue in more detail, it is time to experiment and create prototypes for solving the problem/issue. It is

important not to lose sight of the first three phases to ensure that the prototypes meet the desired outcomes. There are no right or wrong prototypes; however, prototypes can be assessed to determine their ability to solve the problem/issue. Failure is part of learning, testing, and creating and often results in more interesting, innovative, and creative solutions in the end.

e. **Refine/Gain Feedback/Communicate:** Testing the prototypes, gaining feedback from those who are impacted, and refining the final product are all part of solution-finding and more often than not, lead to new problems and issues to tackle!

The Design Thinking process has been adopted by many school jurisdictions and educational resource developers. The Calgary Board of Education has developed a useful infographic depicting the DT process and how it can be used for instruction and learning that is very useful: http://schools.cbe.ab.ca/b343/pdfs/2016-2017/Design_Thinking_Process_Branded.pdf

The *Wading in for Water* Action Project utilizes a design thinking approach to developing student-generated proposals for local water issues.

F. Organization of the Module

Wading in for Water consists of a unit plan template and lesson sketches developed for Science 14 Unit D: *Investigating Matter and Energy in the Environment.* Each lesson outline consists of the following components:

- **Setting the Stage** – includes correlation to Program of Studies knowledge, skill and attitude outcomes for the topic; planning notes including resources and materials required; and a description of the type of lesson (i.e. lab, field experience, brainstorming, etc.)
- **Topic Openers** - hooks for learning that may include videos, activities, demonstrations, questioning, classroom discussion among other strategies.

- **Lesson Sketch** – instructional outline including questions, discussion topics, activities, demonstrations, laboratory or field activities, videos, etc.
- **Closing Ideas** – suggestions for wrapping up the lesson and preparing for the next lesson
- **Notes** – add your own ideas based on your location, unique issues, and student interests.

NOTE: The hooks for learning and lesson sketches are suggestions only. Additional ideas and approaches that are more appropriate for your students' interests should be substituted as required. Student assessment strategies (diagnostic, formative, and summative) have not been identified nor developed, however the suggested instructional approaches provide for a variety of assessment opportunities throughout the unit.

G. Long Range Planning

Science 14 Unit D: *Investigating Matter and Energy in the Environment*	*Career and Technology Studies* *ENS 3910 Action Project (D)*
Timeframe: • Represents 25% of the Science 14 course • Consists of 14 lessons, including a local field study of an aquatic ecosystem, that should be completed in 14-15 classes • Represents ~ 18-22 hours	**Timeframe:** • 100% of ENS 3040, 100% of ENS 3910, ~20% ENS 3050 • Consists of 9 lessons (varying from one class to three classes for a total of 12-15 classes) and the implementation of the action project (dependent on student and teacher interest) • Additional materials will be made available for the completion of ENS 3050 (which will involve additional hours) as the credits for ENS 3910 are dependent on the completion of both ENS 3040 and ENS 3050. • Represents ~ 20 hours

To Do / To Consider / To Gather:

- Materials / Equipment Listing for the Field Study are found in Appendix D

Useful Websites and Resources:

- Field Experience: River Watch Program (http://www.riverwatch.ab.ca/)
- Alberta Lakes Management Society (http://alms.ca/)
- Alberta Irrigation Projects Association (http://aipa.ca/)
- The Clean Water Birthday Project (https://www.cleanwaterbirthdayproject.com/)

NOTE:

- Ideally students will be examining local water samples from ponds, creeks, sloughs, etc. These water samples may be maintained in an aquarium in the classroom/lab.
- If ordering aquatic microorganisms, do so prior to beginning the unit.

Safety and Risk Management:

Each School District has their own prescribed procedures for addressing risk management and safety of students, staff, and volunteers while they are engaged in off-site field experiences. Please review your locally developed guide and ensure that all the necessary considerations for your excursions meet the requirements of your department, school, and jurisdiction.

Student Assessment:

Specific student assessment materials are NOT included in this module. Teachers should determine the most appropriate Assessment for Learning (AfL) and Assessment of Learning (AoL) for their students. Consider a wide variety of strategies to provide multiple opportunities for students to demonstrate their understanding, skills and developing attributes or habits of mind.

NOTE: Consider the role that industry, community partners, environmental organizations, local and provincial governments, and others may play when engaging students in a balanced discussion about water in your community. There are both challenges and good news stories to share regarding each stakeholder's social responsibility and the ways in which emerging technologies and innovative thinking contribute to managing and caring for our water and other natural resources.

Science 14 Unit Outline

Program of Studies: https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Understanding by Design Unit Planning Template: http://jaymctighe.com/resources/downloads/

<table>
<tr><th colspan="3">Stage 1 - Identify the Desired Results (Programs of Study)</th></tr>
<tr><td rowspan="6">ESTABLISHED GOALS
Social and Environmental Emphasis:
• Issues/decisions relating to how science and technology are applied
• Skill emphasis on the use of research and inquiry skills to inform decision-making processes
• Students seek to analyze information and consider a variety of perspectives

(Science 14 Program of Studies, pp. 7 & 10)</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…
GLO 1: Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity
GLO 2: Analyze a local [water] ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium
(Science 14 Program of Studies, p. 26)</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS
Students will understand that…
• Energy from the Sun sustains living systems and maintains equilibrium in the biosphere
• Matter and energy are recycled along natural pathways
• Human activity has an impact on the movement of matter and energy in the biosphere, raising global concerns about sustainability
(Science 14 Program of Studies, p. 26)</td><td>ESSENTIAL QUESTIONS
• How is human activity influencing the natural flow of matter and energy in the biosphere?
• Should humans as a species be concerned about the effects of their activities on other species and the environment?
(Science 14 Program of Studies, p. 26)</td></tr>
<tr><td colspan="2">Acquisition</td></tr>
<tr><td>Students will know…
• See student learning outcomes in Science 14 Program of Studies, p. 26</td><td>Students will be skilled at…
• See student learning outcomes in Science 14 Program of Studies, pp. 27-29</td></tr>
<tr><th colspan="3">Stage 2 – Determine the Evidence of Student Learning (Assessment)</th></tr>
<tr><th>Evaluative Criteria</th><th colspan="2">Assessment Evidence</th></tr>
<tr><td>Rubric</td><td colspan="2">PERFORMANCE TASK(S):
• Water Action Project</td></tr>
<tr><td>Teacher Identified</td><td colspan="2">OTHER EVIDENCE:
• Teacher identified (may include anecdotal records, observations, conversations, lab reports, posters, presentations, public service announcements, quizzes, tests, etc.)</td></tr>
<tr><th colspan="3">Stage 3 – Design Instruction (Lesson Sketches)</th></tr>
<tr><td colspan="3">Outlined in next section</td></tr>
</table>

Lesson #1: Setting the Stage

Topic:	**Science 14 Unit D Introduction (Focus on Water)**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity • General introduction • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes

	· https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	- Paper for Groundwater Activity (keep to review in Lesson #5) *Safety First: Refer to your school/department/district regulations* - Demo: Ice cubes and a glass of water -classroom with a sink for the team building activities -for each group: • eye dropper • Penny • Beaker • Access to water • Flat surface • Clear glassware without a pouring lip • Large box of paperclips (have a few extra boxes for backup) • Lesson 2 eggs preparation 24 hours in advance
Type of lesson	Brainstorm Discussion Team Building water activities
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	**Intro/ Hook ideas:** At the beginning of the unit it is useful to gauge students' current understanding of water and the hydrologic cycle. As an introductory activity, ask students in small groups to draw and label a diagram of the hydrologic cycle (http://www.sciencekids.co.nz/sciencefacts/weather/thewatercycle.html). An important component they may miss is groundwater. Use The Groundwater Foundation website (http://www.groundwater.org/get-informed/basics/groundwater.html) to lead a class discussion for the purpose of: • Understanding the basics of groundwater – **Misconception Alert!** Students may mistakenly think that groundwater is found as puddles, reservoirs or streams underground • Recognizing the importance of groundwater within the hydrologic cycle • Identifying potential threats to groundwater and the impact to the hydrologic cycle • Determining reasons for monitoring local water conditions both above and under ground (seen and unseen)

Lesson Sketch	1. Brainstorm Questions: • What do we already know about the water cycle? • What is another name for the water cycle? • How do the words that we have brainstormed about water connect to one another? • What are the terms to describe the changes from liquid/solid/gas? 2. Properties of water: Questions: • Demo: Drop ice cubes in a glass of water. Which state of water is more/less dense, liquid or solid? What happens to the water in lakes during the winter? What is a unique property of water when water freezes? Not sure? Think about ice fishing. Ice floats, so why is that important to fish in the winter? What if they run out of oxygen? Imagine if ice was more dense than liquid water. What would happen to the lakes in the winter? How would that impact the ecosystem? Consider the plants and animals (like fish) in the lake. • Based on the last point, what temperature is water most dense (heaviest)? Least dense (lightest)? This is an unusual behaviour – other substances are usually more dense in the solid form. Why might this be an important characteristic of water? • At what temperature does water freeze/boil? What if water is not "pure", will it freeze/boil at 0 C and 100 C? • This is a good opportunity to discuss the *particulate nature of matter* – a Big Idea of science and necessary for understanding water quality issues (https://www.scoe.org/files/ngss-particle-model.pdf) Discuss what (generally) happens to particles of matter as they gain or lose energy. What is different about water? 3. Team building activities: *Safety First: Refer to your school/department/district regulations* Divide the class into groups of 4-5 students, and assign each group member a specific role (see Appendix B) a. Coin and dropper: surface tension Which group can get the most water drops on the penny? What did the winning group do to be successful? Now do this again, and add one drop of liquid soap Teacher resource video https://www.youtube.com/watch?v=uCZ1AmoQGm8 b. Paperclip in a small glass of water (a vessel without a lip such as a measuring cup or beaker is NOT recommended): surface tension, adhesion and cohesion. Teacher resource video https://www.youtube.com/watch?v=CeiZfBu7ehE
Closing ideas	Does water have memory? Dinosaur "pee" crash course video: https://www.youtube.com/watch?v=o_bbQ0m3wuM _Students are intrigued by the idea that the water we have on Earth today is the same, recycled water that was here millions of years ago). This is an opportunity to discuss *conservation of mass (matter) and energy* – necessary for understanding cycling in the environment. Video (time 4:36): http://ed.ted.com/lessons/the-law-of-conservation-of-mass-todd-ramsey

Notes:

Lesson #2: Setting the Stage

Topic	**Matter Cycles**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity • Describe, in general terms, how water, carbon, oxygen and nitrogen are **cycled** through the biosphere • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Estimate measurements • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • State a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats

	to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	*Safety First: Refer to your school/department/district regulations* Book a science lab with the following equipment for each lab group: • Hotplate • Flask • Stopper • Sugar • Salt • Water • Thermometer • 500 mL beaker x 3 • Various sizes of graduated cylinders • Ring clamp • Timer (stopwatch or cell phone timer) Note: Add in 2 eggs (or more) to be placed in vinegar the day before to remove the calcium carbonate shell. Once it is removed, the mass should be recorded and then placed in the different substances for at least a few hours.
Type of lesson	*Lab safety review* Lab Discussion **NOTE:** Lab Station Activities – Student Sheets found here
Word Wall	Listed in Appendix A

Setting up Lab Stations:

Lesson #2 makes use of lab stations. The National Science Teachers' Association (NSTA) has an excellent article on how to set up lab stations including all of the things you need to consider. It also provides a template for assigning student roles within each group to increase learner engagement. Access the article here:

http://www.nsta.org/publications/news/story.aspx?id=53323

Information on assigning student roles can also be found in Appendix B

Getting Started

Topic opener "hooks"	**Intro/ Hook ideas:** Give the following scenario: You are stranded without a cell phone, have run out of drinking water and other supplies and are: • on a desert island OR • lost in the forest OR • your car runs out of gas while driving in the Badlands OR • lost at sea Challenge: You need water to survive, so how do you get safe drinking water that doesn't make you sick? • Discussion about evaporation and condensation; what supplies would you need to make this happen? Or, if you have a match and could boil the water, how long until it is safe? Discuss why tea is a safe option for hydration historically and in developing countries. Refer to the UNESCO Sustainable Development Goals http://en.unesco.org/themes/education-sustainable-development
Lesson Sketch	1. Review lab safety rules and expectations: *Refer to your school/department/district regulations* Teacher resource: http://www.uft.org/chapters/lab-specialists/lab-safety-rules-for-students 2. Students will be placed in groups to visit 5 water lab stations, allowing them to practice simple laboratory skills and the Scientific Method. Some of these skills will prepare for the Water Quality Action Project. Each group member should be assigned a role (See Appendix B) Teacher Resource: http://www.nsta.org/publications/news/story.aspx?id=53323 **NOTE:** The stations should take students an equal amount of time to work through. Suggestion: Only allow a station change when all groups have completed the station. Station 2 has three parts and students can move freely between them. See the attached student sheets, lab set up images, and station set up sheet. (Student Lab Stations Activity Sheet). Ask students to clean up the lab station as they found it before moving to the next station. • Station 1: Build a model of the hydrologic cycle. Collect condensation from saltwater using a hot plate, beaker, tinfoil, and ice cubes. Teacher reference:

(https://thewaterproject.org/resources/lesson-plans/rainmaker-experiment)

- Station 2a: Measure volumes of water using several graduated cylinders - show how to measure and explain *meniscus*. Measure quantity of water correctly (use various sizes of graduated cylinders and beakers). Have a few capillary tubes of varying sizes set up to further emphasize correct and accurate measurement. Teacher reference: https://water.usgs.gov/edu/meniscus.html

- Station 2b: measure the mass of an egg in distilled water, and then in salt water (prepared the day before & remove the shell with vinegar).

- Station 2c: Is salt water more or less dense than freshwater? Place an egg in each to compare. Challenge: How could you float the egg in the middle of the beaker (not floating at the top or resting on the bottom).

- Station 3: Determine how much sugar can be dissolved in cold vs warm vs room temperature water using a ring clamp, hot plate and thermometer. Be sure to accurately measure the temperature of each container of water? What other variables need to be controlled (i.e. volume of water). Using a timer, determine how long it takes to dissolve the sugar. Is there a maximum amount of sugar that will dissolve? Teacher resource: http://www.sciencekids.co.nz/experiments/dissolvingsugar.html

- Station 4: How long does it take to boil tap water? Salt water? "Contaminated" water (i.e. soft drink or Gatorade)? Implications on a large scale. Predict what may happen when these substances freeze.
    - Measure the temperature of tap water, add some ice cubes and measure the temperature again.
    - Sprinkle a tablespoon of salt and measure the temperature again.

- Station 5: Water movement with temperature changes. How does water react to different temperatures? Adding heat into the system makes molecules move more quickly. Set up a large glass pan of tap water over a candle on one side and to a bowl of ice cubes on the other side. Add drops of food colouring to the water, one drop where the candle is under the pan, and one drop where the ice cubes are under the pan. Draw a model to illustrate that water molecules move more quickly when heat is added and more slowly when heat is removed.

3. Return to the classroom after the groups have visited all 5 stations.

- Matter cycles: Using the stations, discuss where the water goes to and comes from. Does it ever leave the system? No! Water changes form – solid, liquid, vapour. Now we can say that matter doesn't leave the system, it moves, transforms, but doesn't leave.

    - Carbon Cycle: What are fossil fuels? Where do they come from? How are they extracted? How did they get there? Based on what we discussed about matter cycling and not leaving the system, where does carbon go

	once it is extracted? Is it considered renewable? What about carbon cycling from sources that are not mined by humans? Carbon is a building block of life making up important components such as DNA, carbohydrates (breads and sugars), lipids (fats) and proteins (meat, tofu, beans, etc.). Emphasize the link between the carbon cycle and the oxygen cycle. Image: http://www.sciencekids.co.nz/images/pictures/earth/carboncyclediagram.jpeg Teacher resource: https://www.youtube.com/watch?v=2D7hZpIYlCA o Oxygen Cycle: photosynthesis, respiration, combustion (related to carbon). Image: https://www.exploringnature.org/graphics/ecology/oxygen_cycle_color72.jpg o Nitrogen Cycle: Nitrogen is the largest percentage of gas in our atmosphere. How do we get it into a usable source? Bacteria rules! Discuss nitrogen fixing bacteria & relation to legumes, decomposers, other bacteria that convert back to atmospheric nitrogen. What about fertilizer? Fertilizer = animal waste and compost, or sprinkled from an energy intensive process. What about lightening? A chemical reaction occurs! Image: https://www.pmfias.com/wp-content/uploads/2016/05/Nitrogen-Cycle-wiki.jpg Teacher resource: https://www.youtube.com/watch?v=leHy-Y_8nRs
Closing ideas	Discussion: What is a Carbon Tax? Why did Alberta implement one in January, 2017? Based on what we have learned, we know that matter cycles, so why have a carbon tax when the amount of carbon is always the same? Rationale: https://www.alberta.ca/climate-carbon-pricing.aspx Calculate how much a household will be pay each month: http://www.cbc.ca/news/canada/calgary/multimedia/alberta-carbon-tax-calculator-1.3900339

Notes:

Lesson #3: Setting the Stage

Topic:	**Energy Flows; Matter Cycles**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge:	Students will: **1.** Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity • explain the role of living systems in the **cycling of matter** in the biosphere *(e.g., food chains)* • explain why the **flow of energy** through the biosphere is linear and noncyclical • compare the **recycling of matter** by society with the natural **cycling of matter** through ecosystems • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Select and integrate information from various print and electronic sources • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify new questions and problems that arise from what was learned
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	- Book a computer lab - Demo: Bowl, tap-water, cooking oil, and 2 feathers - Make sure the digital activity loads/works for the chain/cycle activity
Type of lesson	Group computer activity **NOTE:**

	• Student Sheets found here for Aquatic Food Chains and Food Webs • Student Activity Sheets found here for Energy Pyramids
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	**Intro/ Hook ideas:** Ever heard the expression "like water off of a duck's back"? What does this mean? Birds have natural oils in their feathers that protect the body of the duck from getting wet and suffering from hypothermia. Remember oil and water do not mix. • Dip a feather into a bowl of water, and observe what happens to the feather. What will happen when a duck lands in an oil spill? • Pour some cooking oil into the bowl of water, and make some observations. Discuss how this may affect the duck • Dip the dried feather into the bowl and remove it. Make some observations on how the feather looks. Can this oil be washed off by the duck? No, because oil and water do not mix. Now the natural oils have been removed by the spill, and makes the duck vulnerable as the water no longer beads on the feather. Now the duck is prone to getting hypothermia. How can the duck's natural oil be restored? How do you remove oil from your hand? • Pour a drop of cooking oil onto a volunteer student's hand. Soap! o Play the Dawn commercial (0:30): (https://www.youtube.com/watch?v=CLU1wB1Tzkc).
Lesson Sketch	1. Ask students: What is the 'biosphere'? What makes up the biosphere? [Answer: Hydrosphere, lithosphere, and atmosphere and their interactions] 2. Emphasize past learning (review) from lesson #2: matter cycles 3. Matter cycles, but what about energy from the sun? It flows. Let's take a look: Where does energy from the sun go? The Plants = producers; then where? Consumers. Each time there is energy transferred energy is used for the organism to produce body heat, waste, reproduce, etc. So, if a bird eats a mosquito, does 100% of the energy get transferred to the bird? No. Energy is used for the mosquito to fly, to mate/produce eggs, etc. 4. Aquatic Food chain/web computer activity (See activity page) • Important, before heading to the lab: **Internet safety chat & reliable sources reminder** 5. Energy pyramids • Using the following resource (turn on sound/volume), go through the terms and scenarios, of Forest, Prairie, Ocean. http://www.harcourtschool.com/activity/science_up_close/314/deploy/interface.swf Discussion questions (draw the pyramid to work out answers): • Will you consume more energy from eating shrimp (primary consumer) or tuna fish (tertiary consumer)? Which is more sustainable? If we were to remove these from the pyramid how would the outcome differ? • Which level of the pyramid is most important to protect? This would also be a good place to discuss endangered species.

	• Should a primary consumer or a tertiary endangered consumer take priority when considering protection? 7. Question: What is the difference between **recycling of matter** by society and the natural **cycling of matter** through ecosystems?
Closing ideas	How wolves change rivers video (time 4:34): http://blog.ted.com/video-how-wolves-can-alter-the-course-of-rivers/ • **Note**: Red deer are also known as elk. Questions relating to the video: • Why were the wolves missing from this ecosystem? • How can wolves change a river? • How do you feel, when you see how adding one species (wolves), can change everything? • Think of an example of an organism (plant or animal) that has either been added to a place it never existed before. • Think of an example of an organism that has gone extinct or is at risk of extinction, and how that may change the ecosystem Now let's think of the natural ecosystem where we live. • What are the main sources of water in our community? • What is upstream/downstream? Let's talk about Water Quality. Quality is a term used to determine how good, or how safe the water is for humans. Are there any contaminants? Is it clean? Can you get sick from it, what condition is it in, etc. Later in the unit, we will be conducting a Water Quality Action Project to help us determine what the water quality is of a nearby water source. Things to consider: • Is it safe to drink directly from the water we just identified as our main water sources? Why? • Even if the water LOOKS safe, clear, and fresh, is it safe to drink? Are there animals upstream that may have defecated in the water? Dogs, cattle, deer, etc. • Might the concerns of water quality be different in other parts of the world? Although a universal concern, less developed countries may not have a way to deal with any water quality concerns, and the risk of getting sick is more likely. Teacher web resource: http://waterbornepathogens.susana.org/ • What do we know about *E.coli*? Giardia (Beaver Fever)? Salmonella? Hepatitis? Rotavirus? Botulism (Botox connection)? o Video (time 1:28): https://www.youtube.com/watch?v=0YAfpGlNLmc Video (time 4:42) https://vimeo.com/56012237

Notes:

Lesson # 4: Setting the Stage

Topic:	**Human Impacts: The Good, Bad and Innovative**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: **1.** Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity • assess the costs and benefits of technological developments that produce materials the ecosystem cannot recycle *(e.g., disposable plastics, heavy metals)* • assess the impact of modern agricultural technology on the natural pathways of **recycling matter** • explain how biodegradable materials reduce the impact of human-made products on the environment • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf • http://leaf-republic.com/media/
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task

Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	Have the groups organized ahead of time for the jigsaw activity Sign out mobile laptops/tablets in advance. Have one/two computer(s) available for each group.
Type of lesson	Discussion Jigsaw **NOTE:** Student Sheet for Jigsaw found here
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Oregon man urinates in the drinking water reservoir. Video (time: 1:17): http://www.usatoday.com/story/news/nation/2014/04/17/water-reservoir-urination/7814581/ • Should they have drained the reservoir? • Where is our community's drinking water reservoir? How is it protected?
Lesson Sketch	• Discussion: o What is technology? What is the purpose of technology? Give some examples of technology you used so far today. Examples: coffee maker, hair dryer, bus/car, cell phone. Describe some pros and cons to this technology. What parts of this technology cannot be recycled or reused? Heavy metals, plastics, other? Depending on your community, even if something has a symbol that shows it is recyclable with the Mobius Loop symbol, but it may not be able to be processed due to cost or convenience in many communities, so it still ends up in the landfill. Teacher Resource: http://www.davidsuzuki.org/publications/downloads/2010/plasticsbynumber.pdf o Look up your community, and try a few items for the closest location for recycling them. https://callcentre.emergeknowledge.com/search/drop_down/alberta?jurisdiction_material=1445&location_method=area&place=11132&address=&distance=&commit=Search o But what does it become? Teacher resource: https://www.edmonton.ca/programs_services/garbage_waste/recycling-what-does-it-become.aspx o Regarding renewable and non-renewable resources: Define. Brainstorm some local examples of each. o What are some of the local industries around your community? Forestry, agriculture, oil & gas, etc. o What are our local industry concerns when it comes to renewable/non-renewable resources? How do we find out what is being done? Who is in charge of this? Should we even care?

- Pollution. Can it be undone? Timeline? Pros and cons of society recycling.
- What is consumerism? If matter cycles, where does material end up that can/cannot be recycled? Is it okay for material to build up in one place, while being depleted of resources someplace else thousands of km away? Length of time (long/short cycling of carbon). What about plastic? If time permits, Water Brothers episode: Plastic Ocean, may be viewed (28 minutes): http://thewaterbrothers.ca/plastic-ocean/

- Discussion: What are some consumer products that "bug" you? You know it would be difficult to stop using, but know that they add to the problem of garbage/pollution/ waste? Possible answers: Plastic straws, plastic forks, and plastic six-pack holders. Keeping these items in mind, now let's think outside of the box: What about **biodegradable** materials? What does this mean? How can individual citizens and/or industry improve their technology to minimize waste? Examples:

  - Six-pack holder in the oceans. Pros/cons? Video (time 1:52): https://www.youtube.com/watch?v=-YG9gUJMGyw
  - Edible spoons. Pros/cons? Video (time 3:42): https://www.youtube.com/watch?v=r4Cc5zmy0eY
  - Edible cups video (time, less than 1 minute): https://www.loliware.com/
  - Biodegradable leaf plates video (time 1:59): http://leaf-republic.com/media/
  - Water without the bottles: http://www.skippingrockslab.com/
  - How can we prevent harm when developing new technology? Discuss the design process (see a discussion of Design Thinking here)
- Unfolding Innovation: There is a way to reduce or reuse of some materials such as paper towels in a different way. Depending on the method, this can reduce waste, and operate in either a carbon neutral or carbon negative capacity for an organization. This technology is called Gasification. Are there any negative impacts from this type of innovation?
  - How it works Video (time 4:52): https://www.youtube.com/watch?v=cjyAR7EkZIc&feature=youtu.be
  - Commercial for a local Calgary company employing this technology Video (time 5:01): https://www.youtube.com/watch?v=ZisQHpYLyac&feature=youtu.be
  - An article looking at the Alberta Governments interest in this technology: http://www.cbc.ca/news/canada/calgary/plasma-gasification-alberta-proposal-1.3373979
- Jigsaw activity: What is industry doing to improve water recovery? (see attached worksheet found here)
  - Oilsands
  - SAGD
  - Farming (cattle & grain)
  - Forestry
  - City/town use
  - Tourism

Closing ideas	Wabamun Lake is a provincial park, and adjacent to the lake is the Sundance Power Station that operates the Highvale Coal Mine and Power Plant. This is Western Canada's largest coal-fired electrical generating station. Warm water is deposited into the lake after it has been cleaned, but does the temperature of the water have any long term effects? • Teacher resource: http://www.transalta.com/facilities/plants-operation/sundance/ and http://www.transalta.com/facilities/mines-operation/highvale-mine/ • To show how it is highly monitored by the government see the following (search the word "temperature" for specific info): https://extranet.gov.ab.ca/env/infocentre/info/library/6138.pdf Possible discussion starters: • Different organisms might prefer different temperatures. How would that change the entire food web? • Would the warmer lake water freeze in the winter? What is the potential impact? • How might the coal mine and power plant have positive and negative effects on the environment? Are there other considerations to take into account such as: political, economic, social? ****Note:** Consider the role that industry, community partners, environmental organizations, local and provincial governments, and others may play when engaging students in a balanced discussion about water in your community. There are both challenges and good news stories to share regarding each stakeholder's social responsibility and the ways in which emerging technologies and innovative thinking may contribute to managing and caring for our water and other natural resources.

Notes:

Lesson # 5: Setting the Stage

Topic:	**Pros and Cons to Technology and Innovation**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: **1.** Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity • identify and assess the needs and interests of society that have led to technologies with unforeseen environmental consequences *(e.g., fishing technologies that result in harvesting more than the rate of reproduction, use of pesticides such as DDT, impact of driving a car on atmospheric compositions)* • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf

Planning ahead	-Set up Bioaccumulation Activity game: page 11 of http://aep.alberta.ca/about-us/documents/TeachersGuide-PeregrineFalcon-2000.pdf -Have the Groundwater Activity drawings from Lesson #1 available to view - Assessment for Outcome #1 would be ideal to during the next lesson.
Type of lesson	Small and large group discussion Bioaccumulation Activity Brainstorm
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: • What is DDT? What was it originally developed to do? Was it created to help or hurt people? What does it do in the long term? Is it still being used? What is the alternative? • Resource: https://www.epa.gov/ingredients-used-pesticide-products/ddt-brief-history-and-status and http://npic.orst.edu/factsheets/ddtgen.pdf o Connection to mosquitos and more recently to Zika Virus, or any other concerns or disease that is spread by insects (dengue, chikungunya, malaria, bed bugs, ticks and Lyme Disease, etc.) Human health and safety vs. ecosystem biomagnification and consequences. • In Alberta, a direct effect of DDT is how it moved up the food chain and has harmed the shell thickness of the Peregrine Falcon eggs. • Predict what happens when the shell is thin. It is easily crushed! This directly impacts that survival of individuals and the species. This top predator was almost extinct (at risk) for many years, until a Recovery Plan was put into place by the Alberta Government to help protect them, and to help breed them and release them back into the wild. • DDT was banned in 1972, and now much safer pesticides are used where needed to prevent this situation from happening again. It has been banned for almost 40 years, and the Peregrine Falcons in Alberta are still "At Risk" of extinction. • Short student video (time: 2:55): https://www.youtube.com/watch?v=Y_dKOTgdS4c • Fact sheet: http://aep.alberta.ca/fish-wildlife/wild-species/birds/falcons-woodland-hawks/peregrine-falcon.aspx • Teacher Resource: http://aep.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/birds/documents/SAR-AlbertaPeregrineFalconRecoveryPlan-Mar2005.pdf Bioaccumulation Activity: • Refer to the Teacher Resource developed by Alberta Environment found here: http://aep.alberta.ca/about-us/documents/TeachersGuide-PeregrineFalcon-2000.pdf • Using Activity 2 (p. 11) of the document, students learn about peregrine falcons and the use of DDT in the 1950's and 1960's. • Play the game to illustrate how a toxin such as DDT may enter the food chain and become magnified as it moves up the consumer levels to the peregrine falcon eventually impacting survival of the species. • Compare humans and peregrine falcons in their respective food chains. How could

	bioaccumulation and **biomagnification** serve as a threat to humans? Discuss the difference between "**bioaccumulation**" (i.e. an organism ingesting more and more toxins) and "**biomagnification**" (toxins being passed along through the food chain/web) • Bioaccumulation, does it go away? Which organisms will be most at risk? Belugas in the Arctic ocean link: https://www.whalefish.org/single-post/2014/04/29/Bioaccumulation-and-Biomagnification-in-the-marine-environment And Depending on time of year, check out a web cam, there are many to choose from in the prairies, here is one link: http://www.ab-conservation.com/wildlife-cameras/peregrine/ • If we know that some materials cannot be recycled, how does this fit into the statement "matter cycles", whether we are talking about water, carbon, nitrogen, or oxygen? What happens? Brainstorm some examples.
Lesson Sketch	1. Groundwater Activity: Review from Lesson #1 the students' groundwater diagrams. Let's find out more about the water that we can't see: http://aep.alberta.ca/about-us/documents/FocusOn-GroundwaterBasics-2014.pdf 2. What is a watershed? Discuss the main watersheds in Alberta and where they drain on the continent. Resource: 3. List of watersheds: https://albertawilderness.ca/issues/wildwater/headwaters/ and http://albertawater.com/learn/where-does-alberta-s-water-come-from/what-s-a-watershed Image of watersheds: https://rivers.alberta.ca/ 4. Reference: maps of Canada with full watersheds: http://www.nrcan.gc.ca/earth-sciences/geography/atlas-canada/selected-thematic-maps/16888 • List where the Alberta watersheds drain: Arctic Ocean, Hudson's Bay, and Pacific Ocean (the tiny segment of the Milk River Basin drains into the Gulf of Mexico) 5. Where are farms generally located? This is a topic to carefully approach. Nutrients are gathered (crops) every year and shipped away. The nutrients (such as nitrogen, phosphorus, potassium, sulfur, copper, and many others) need to be replaced to maintain the correct balance, usually by using fertilizer. Eutrophication occurs when nutrients run off the land and accumulate in places not accustomed to them. This is a wonderful segue to discuss the importance of wetlands (http://www.mbgnet.net/fresh/wetlands/what.htm) • prairie potholes • bogs • fens • rivers • lakes, and streams ** **Remember:** Matter cycles, but what if more ends up in one spot in a short period of time? 6. We have learned about the water cycle, the carbon cycle, the oxygen cycle and the nitrogen cycle. If matter cycles, why would we care if it is cycled from one form to another? What we have will always be there, just the form changes. Right? So why might people want to protect groundwater? Or worry that nutrients are taken from the soil when you grow crops? 7. Nature of Things Episode: Save our Lake (~45 minutes) Depending on the group of students, you may want to pause in different spots to discuss what the video highlights http://www.cbc.ca/natureofthings/episodes/save-my-lake Sample script for introducing the field study: *Our class will be monitoring water in Alberta, and*

	*contributing to a database of information around the province. We will be collecting data from (list selected location here). Over time, we will be able to monitor the data to see if things are changing in the different water bodies. We will be entering the data online on the SEEDS website during lesson #11(*https://seedsconnections.org/share-about-water*). 'Monitoring' is about collecting data, not making decisions. We will be able to analyze our data over time and from that possibly develop a management plan or suggestions to present to local officials.* 8. What are the impacts on water if humans change the landscape? Divide the class into groups of 2-3 students and ask them to brainstorm how their assigned industry may impact water. The industry may include; grain farming, cattle ranching, mining, forestry, fracking, fishing, tourism, etc. **NOTE:** Consider the role that industry, community partners, environmental organizations, local and provincial governments, and others may play when engaging students in a balanced discussion about water in your community. There are both challenges and good news stories to share regarding each stakeholder's social responsibility and the ways in which emerging technologies and innovative thinking may contribute to managing and caring for our water and other natural resources. 9. Now let's identify and assess the needs and interests of society that have led to technologies with unforeseen environmental consequences a. What is a fishery? http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/species-especes-eng.htm • It is the Department of Fisheries and Oceans to ensure that a fishery is sustainable. What does that mean? • How does a fishery collapse? fishing technologies that result in harvesting more than the rate of reproduction, Resource: *http://www.rcinet.ca/en/2016/10/06/canada-could-suffer-another-fishery-collapse-warns-official-gelfand-oceana/* b. Are pesticides bad? Discuss why humans rely on pesticides, pros/cons to modern agriculture. What are the alternatives? http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/pesticide-food-alim/index-eng.php and http://helpingcanadagrow.ca/
Closing ideas	Ask: What is potable water? Water that is safe for humans to drink. • Who has a right to potable water? http://www.un.org/waterforlifedecade/human_right_to_water.shtml and http://en.unesco.org/themes/water-security (UNESCO Sustainable Development Goals) • Should we trust our water supply in Alberta? Explain. • Water crisis in Walkerton, Ontario: http://www.cbc.ca/news/canada/inside-walkerton-canada-s-worst-ever-e-coli-contamination-1.887200 • Where does your water comes from? What if you drink from a well? Is it safe? How do you know? According to Alberta Health Services Environmental Public Health department, a private residence with a well can be tested for bacteria twice a year and once every three years for chemistry, free of charge. If the results come back with an issue, the water must not be consumed and steps such as "shock chlorination" must be taken then tested again to make the water safe to drink again. http://www.albertahealthservices.ca/info/service.aspx?id=1052212 • What about First Nations water supplies? http://edmontonjournal.com/news/local-news/alberta-first-nations-still-lack-consistent-access-to-clean-water • Is bottled water safer than tap water? http://news.nationalgeographic.com/news/2010/03/100310/why-tap-water-is-better/ • What happens if you run out of water during an outdoor trip (hunting, fishing, hiking, etc.)? There are different emergency supplies you can pack for such circumstances to prevent serious illness such as *E.coli* or *Giardia* (beaver fever) contamination. There are drops/tablets

	that can be dropped into the water (less expensive), and there are also small hand pumps that filter the water (more expensive): https://www.mec.ca/en/products/gear/camping-and-hiking-gear/water-bottles-and-filters/water-treatment/c/1236

Notes:

Reminder: Next class is an ideal time to assess Outcome #1.

Lesson # 6: Setting the Stage

Topic:	**Mid-Unit Assessment and Field Study Preparation**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • describe, in general terms, the characteristics of two Alberta biomes *(e.g., parkland, boreal forest, mountain, grassland)* • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Estimate measurements • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

	• Evaluate individual and group processes used in planning, problem solving, decision making and completing a task
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	• This is a natural break for assessment of outcome #1. • Have the field study equipment available for the next week or so (see equipment list) *Safety First: Refer to your school/department/district regulations* • Have all the equipment laid out with instructions for use for students to practice how to use it, including: o Measuring pH (strips/meter) o Dissolved oxygen o Plant id, insect id, mammal id, single celled organism identification sheets/books o Nitrogen/phosphorous/magnesium/hardness o Flow rate o Temperature o Microscope use & review o Preparing a wet mount practice o Order microorganisms from science supply/ collect water from a fish aquarium
Type of lesson	Outcome #1 Assessment Field study introduction and preparation Hands on practice of equipment
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	***This is an ideal time to have an Outcome #1 Assessment.** Intro/ Hook ideas: • What are some of the abiotic differences between Medicine Hat and Fort McMurray? Consider the following: o Annual average precipitation and temperature / summer vs. winter in each locale o Industry and local natural resources. o Length of day and night in the summer and winter in each locale o Landscape features

Lesson Sketch	1. Which biome do we live in? What makes it different than other biomes? Image: http://biologistsbeyondborders.weebly.com/fun-facts.html 2. What are the 2 main characteristics that make up a biome? Moisture & temperature. Show how the x and y axis of the graph indicate if it is a cold dry/warm dry or cold moist/warm moist. • Reference: http://www.nature.com/scitable/knowledge/library/terrestrial-biomes-13236757 3. Review biotic and abiotic factors of an ecosystem. • Brainstorm some examples of each. Reference: http://www.nature.com/scitable/knowledge/library/terrestrial-biomes-13236757 4. Field Study preparation description/intro. Explain when and where the class is going and what will be collected. Discuss expectations, safety, etc. • Divide class into lab groups of 4-5 students • Assign students to pick a role (see Appendix B) within the group • Brainstorm within the lab groups what data will be important to collect to help assess the water quality of the local aquatic ecosystem. 5. Safety First: Refer to your school/department/district regulations Students have an opportunity to practice using some of the equipment that will be needed for the field study (see Appendix C – microscope use) • Microscope station #1: prepared slides (instructions on use) o https://www.wisc-online.com/learn/natural-science/life-science/bio905/how-to-use-a-microscope • Microscope station #2: make a wet mount with microorganisms o Cover slips o Slides o Microorganisms ordered from science supply/fish aquarium o Organism ID sheet (to laminate) http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/index.html o stain (iodine)
Closing ideas	Why might we want to compare a local aquatic ecosystem to one in another biome? What is happening in our community as compared to Medicine Hat? Peace River? Hinton? Edmonton? Fort McMurray? Around the country and around the world? (This should bring the conversation back to what watershed students live within, and where the water drains.) Connect the discussion to the UNESCO Sustainable Development Goals (http://en.unesco.org/sdgs)

Notes:

Lesson # 7: Setting the Stage

Topic:	**Data Gathering: Data Sheet & Planning the Field Study**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • define ecosystems in terms of biotic and abiotic factors (*e.g., common plants and animals, latitude, altitude, topography)* • - describe how various abiotic factors influence biodiversity in an ecosystem *(e.g., climate, substrate, temperature, elevation)* • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation • Select appropriate methods and tools for collecting data and information to solve problems Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Estimate measurements • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify strengths and weaknesses of different methods of collecting and displaying data • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in

	point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	• Have all of the possible collection equipment available for students to pack up and have ready by the end of class (see list) • At the end of class have the data sheet completed and each group has one copy. • Visit the location a day or two ahead, to ensure conditions are as expected, and there are no safety concerns • If needed, find an extra adult to accompany the group (i.e. Lab Technician, a Teacher's Aide, Administrator, fellow Teacher).
Type of lesson	Discussion Field study preparation and data sheet generation **NOTE:** A Sample Data Sheet is found here
Word Wall	Listed in Appendix A

NOTE:

Ensure that you have met all of your School District's criteria for student safety and risk management for off-site field studies.

GATHER MATERIALS:

See Appendix D

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Is it okay to put microbeads of plastic into personal care items (shampoo, body soap, face scrubs, toothpaste, etc.)? • Watch the short video for students to get a background before discussing (time: 2:12) http://storyofstuff.org/plastic-microbeads-ban-the-bead/ • In 2015 The Canadian government decided that microbeads be banned by 2018. Is this an adequate timeline? Teacher reference: https://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=ADDA4C5F-1 and https://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=ADDA4C5F-1
Lesson Sketch	• Discuss the following terms: ecosystem, biotic factors, abiotic factors, and biodiversity and how they relate. o An ecosystem is composed of living (biotic) and non-living (abiotic) things, and depending on the abiotic factors, the quantity of organisms (biodiversity) can vary: the more different species present, the greater the biodiversity • Predict various biotic and abiotic factors in the aquatic ecosystem to be visited next class. Give students ~5 minutes to brainstorm independently, then write down the list on the board, together as a class most factors will likely be covered (see example biotic/abiotic factors at the end of this lesson). This list will be a great jumping off point for putting together the data sheet. How do abiotic factors influence the biotic factors? Does it matter if: o An area is north/south facing? Yes, north facing gets more shade, and likely to have more trees, while a south facing slope is more likely to be drier and be covered in grass (https://albertaep.wordpress.com/tag/provincial-park/#jp-carousel-3261) o A great example is which side of the street melts first in the spring. Different organisms will feed, sleep, and hunt in these varying conditions. o Higher/lower elevation? Yes, higher elevations are usually cooler, and have harsh conditions such as lack of soil, high winds, etc. Consider Banff or Jasper, where there are a few trees clinging to the rocks with exposed roots and windswept, versus the valley down below where the wolves, bears, deer and elk like to feed http://www.pc.gc.ca/eng/pn-np/mtn/securiteenmontagne-mountainsafety/accidents/~/media/pn-np/mtn/securiteenmontagne-mountainsafety/accidents/2010/2010-08-07(4).ashx?w=590&h=786&as=1 o Warmer/cooler by 10 degrees in the summer? Yes, warmer conditions allow for a variety of different species that cooler climates cannot support. This is also a good place to consider how primary industries like farming might be affected by climate change. Warmer temperatures may allow for more agriculture in the northern parts of our province, but of course there are other factors, such as water sources, precipitation, etc. Also, could that mean that agriculture would be less feasible in the south over time? There are lots of unknown factors. o More/less precipitation? Yes, Drumheller and Medicine Hat have less annual precipitation than Red Deer and Rocky Mountain House and as a result, biodiversity may be impacted. For instance, what species are more adapted to drought conditions?

- Time and again, a change in non-living things (abiotic factors) may impact the living things (biotic factors). **Biodiversity** refers to the variety of species found in an ecosystem or habitat … there could be great variety in different areas, but the specific components may be different.

- Class activity: Using the biotic/abiotic factors, put together a data sheet. This should be a guided activity where specific questions should be asked. What information is important? Time of day? Cloud cover? Why? (see example data sheet). Additional Teacher resource: Alberta Parks Downloadable Data Sets: https://www.albertaparks.ca/albertaparksca/library/downloadable-data-sets/

  - Each group will need one copy of this data sheet for the beginning of next class. Hand in the data sheet, so having lost or misplaced copies does not impact the entire group.

- Discuss the importance of:
- Scientific method, in this case, the importance of sharing results with others, so if other people wanted to conduct a similar study, they would get the same results. If different results are found, either the procedure was not correct, or the results were not reliable, thus the importance of robust data and confidence in drawing conclusions.
- Accuracy and precision. Short video (time: 2:36): https://www.youtube.com/watch?v=8Cl5CeiT7hU
- This is why each group will be collecting data. To make sure we are accurate and precise in sharing our results. What if one group has very different results? Maybe their equipment is not working correctly, or was recorded wrong. Then we know this information collected can be either removed, or tried again.
- Pack up the data collection equipment that have been agreed to be taken to the collection site (see attached equipment list in Appendix D). Set this equipment aside someplace safe and secure, so it is labelled and ready to go at the beginning of next class.
  - Ensure that all students know their role, and come to class on time.
  - Reminder: students who do not attend will leave a large amount of work for their group members.
- Safety First: Refer to your school/department/district regulations

  Practice handling the equipment - continued from last class (could be demos, where things get passed around)
  - Chemistry Station
    - soil/water pH (strips/meter)
    - Nitrogen/phosphorous/magnesium/ hardness
    - Dissolved oxygen
    - Temperature
  - Plant and animal identification station
    - identification sheets/books such as:
      a) Alberta Aquatic Animal Identification Guide: (https://www.albertaparks.ca/media/3287/AquaticGuide.pdf)

      b) Aquatic Plants of Alberta: http://alms.ca/wp-content/uploads/2016/11/ALMS-Aquatic-Plant-Book-1st-Edition-Nov-2016.pdf

      c) Alberta Wetlands Discovery Field Guide: http://ftp.public.abmi.ca//home/publications/documents/375_

	Williams_2015_AlbertaWetlandDiscoveriesFieldGuide_ABMI.pdf
	• Other
	  o Wind speed meter
	  o Water flow rate - calculations (could be as simple as measuring a length and then timing how fast a leaf passes in that stretch (speed = distance time).
	• **Remind students to dress according to the weather and conditions (rubber boots, warm sweater, sunscreen, hat, etc.)**

Closing ideas	Snails in Banff: The Banff Springs Snail is only found in Banff National Park, where the natural hot pools are located. They are on the Canadian Endangered Species list. Teacher resource: http://www.pc.gc.ca/eng/nature/eep-sar/itm3/eep-sar3a.aspx • Banff Hot Springs Snails Recovery, Parks Canada Video (time 7:58): https://www.youtube.com/watch?v=HSl9tMVPg8g • A large concern is when tourists want to "get off of the beaten path" and sneak into hot pools to enjoy. Unfortunately, there is a high risk of stepping on these tiny creatures, and also the residue from products such as hand cream, conditioner, sunscreen, and perfume can wash off in the water, and kill the snails. A tourist was fined $4,500 in 2015 for entering the pools Teacher resource to the news article: http://calgaryherald.com/news/local-news/man-who-swam-in-endangered-snail-pool-gets-4500-in-fines

Notes:

Lesson # 8: Setting the Stage

Topic:	**Field Study: Data Collection Day**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills:	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation • Select appropriate methods and tools for collecting data and information to solve problems Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Estimate measurements • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise • Evaluate individual and group processes used in planning, problem solving,

	decision making and completing a task
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	Field Study Day • Bring a few extra copies of the data sheet from last class • Data collection equipment for each group is ready from last class (see list) • Have some sunscreen, mosquito spray, rubber boots prepared for sharing with students • Several clipboards and pencils • Have a trolley/tray/ space for students to place their samples once they return to class after they have collected their samples • Collection bags/vials, etc. for each group *Safety First: Refer to your school/department/district regulations* • Emergency phone number and cell phone for use during an emergency • Safety protocol such as carrying a first aid kit • If needed, have an extra teacher/ administrator/ lab technician to accompany the group depending on location and group dynamic.
Type of lesson	Field study out of the classroom
Word Wall	Listed in Appendix A

NOTE:

Ensure that you have met all of your School District's criteria for student safety and risk management for off-site field studies.

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: • Hook: field study in a local environment • Have students check in for attendance, sit with their group members, and make sure their equipment and data sheet is located and ready to go. • Notify the office that you are leaving the campus • Pep talk about representing the school when we are out in the community (no horseplay, appropriate language, etc.)
Lesson Sketch	*Safety First: Refer to your school/department/district regulations* Field Study Day: Data collection 1. Lead students to the collection location. 2. Each group needs to collect their own data. Arrange the groups in relatively close proximity, where they are approximately 50 m away from each other. Close enough for safety and for the teacher to rotate back and forth to support groups, but far enough away that students do not distract each other. 3. Depending on the group, if the data is collected early, guide the students around the area pointing out interesting observations. a. Are there shore birds? Watch for a ground nest. b. Are there any human disturbances obvious? Litter, or sound from an adjacent roadway. c. Listen to any bird songs, or a frog chorus d. Watch for insects, including butterflies e. Discuss what is upriver, or what feeds the waterbody, and where the water goes to next.
Closing ideas	• Have students label all samples, and to place their samples on a designated tray/trolley/ lab space that is safe and free of other students until the following class • Have students either hand in their data sheet, or place it with their samples. *Safety First: Refer to your school/department/district regulations* • Take attendance before leaving the field site and again back at school • Check in with the office upon return to school

Notes:

Lesson # 9: Setting the Stage (~2 classes)

Topic:	**Field Study: Lab analysis x 2 classes**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Estimate measurements • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify strengths and weaknesses of different methods of collecting and displaying data apply given criteria for evaluating evidence and sources of information • State a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to

	communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	*Safety First: Refer to your school/department/district regulations* -Lab: Field Study Analysis x 2 classes - have microscopes, coverslips, iodine dye, eye droppers, slides ready - have enough test kits for the water analysis (depends on your school supply). May include hardness, phosphorous, etc.
Type of lesson	Lab: Field Study Analysis
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Would you like to work outdoors for a living? If so, put this experience on your résumé! How much does someone who does this type of work for a living get paid? (ALIS examples) • Hydrometric Technician and Technologist: http://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002547 • Pollution Control Technologist: http://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002708 • Water and Wastewater Operator: http://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71002816 • Chemical Technologists and Technicians: http://occinfo.alis.alberta.ca/occinfopreview/info/browse-wages/wage-profile.html?id=2211 • Biological Technician: http://occinfo.alis.alberta.ca/occinfopreview/info/browse-occupations/occupation-profile.html?id=71001558

Lesson Sketch	*Safety First: Refer to your school/department/district regulations* Lab: Field Study Analysis 1. Gather samples and data sheet from last class and start analysis (see Appendix C – microscope use) a. Microscope o Parts of a microscope: http://cronodon.com/images/Microscope_labelled_2.jpg o Microscope instructions: http://www.microscope-microscope.org/activities/school/microscope-use.htm o How to make a wet mount: http://www.microbehunter.com/making-a-wet-mount-for-microscopy/ b. Water analysis c. Identification o If there were several students who did not attend/were not present for the collection, one option would be to give them the opportunity to do analysis on the tap water so there is a baseline of data for students to compare their results to. When the lab groups have completed the work, ensure that the data sheet is complete. One student from each group (with permission and support of the teacher) will enter the data on the Connections website in Lesson #11. Check over the student data, and store it in a safe location. Teacher link to add the data: (https://seedsconnections.org/share-about-water)
Closing ideas	• What happens to water on the International Space Station? Video (time 1:52 with Chris Hadfield): http://www.asc-csa.gc.ca/eng/search/video/watch.asp?v=1_hsvtey71 • Going further: Why is this important? i.e. Mars colony (reference the movie/book, *The Martian* by Andy Weir, 2011)

Notes:

Lesson # 10: Setting the Stage

Topic:	**Biotic Relationships & Quality of the Ecosystem**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • explain how biotic relationships can be explained in terms of the movement of matter and energy, using food chains, food webs and energy pyramids • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	• 12 nails, a small block of wood with one pre-drilled shallow hole (demo), or 5-6 sets of each for small groups to complete • A large space is required for the activity. Depending on weather, a field/gym/ or any open space.
Type of lesson	• Energy pyramid activity • Discussion **NOTE**: Activity notes found here
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Equilibrium Activity. Depending on time, this activity could be a demo where students can come up and try a design they think may work, or this could also be a small group activity where each group has their own materials. Question: Can you balance 11 nails on 1 nail-head? Materials: • Small wood block with one shallow hole pre-set by hitting a nail a few times into the wood, then removing it (students do not need a hammer) • 12 nails • Teacher video resource with how to solve the question: https://www.stevespanglerscience.com/lab/experiments/balancing-nail-puzzle/ • Based on successfully completing this activity, what is equilibrium?
Lesson Sketch	Review food chains and food webs from lesson #3. Ask students to give a few examples of organisms to work through an example of each. Remind students which way the arrow always points: Follows the energy to the next organism! Does all of the energy get transferred? No, due to energy being used by each organism for reproduction, producing waste, heat, etc. This is why organisms further up the food chain/web need to eat more organisms more often. An example of a food chain diagram: **Grasshopper** ⟶ **Shrew** ⟶ **Owl** ⟶ **Hawk** NOTE: arrows indicate the direction of energy flow. Energy pyramids activity: See attached activity. • **Vocabulary:** Producer, Consumer (primary, secondary, tertiary), decomposer, trophic levels • Why would a vegetarian argue that they get energy in their diet? Think about cultures/populations that have large groups of vegetarians. (Lower in the energy pyramid = more energy)

	Explain how biotic relationships can be explained in terms of the movement of matter and energy, using food chains, food webs and energy pyramids. Use as a discussion point after the water collection and analysis. o Consider local industry here or other human activity o Who is upstream/ downstream from our field study location? o Predict differences if industry was not there o Do some "what if's" What if the water was cloudy? How would turbidity change our data? What if the water was warmer/cooler? More/less nutrients? While discussing these scenarios, be sure to include previous knowledge regarding matter cycling and the flow of energy. Consider how humans can work to improve water quality in the area.
Closing ideas	Is Cloud Seeding the same as Chemtrails? • Cloud seeding is the practice of releasing Silver iodide into storm clouds by a small aircraft to prevent hail. This release forces the moisture in the clouds to be released before damaging hail is formed. Is it real? • Yes. This is a common practice in the Calgary area, as it is prone to hail, due to the proximity to the Rocky Mountains. Is it the same thing as Chemtrails? • No! Chemtrails is a pseudoscience belief that chemicals other than fuel are being released into the atmosphere from commercial airplanes. Who pays for cloud seeding? • Insurance companies pay. Why? Hail is expensive, and costs the insurance companies more money than the act of flying a plane into storm clouds and releasing silver iodide. Student video: https://www.youtube.com/watch?v=VlKe5Q1txxI • Teacher article: http://calgary.ctvnews.ca/sowing-seeds-on-the-edge-of-the-storm-to-reduce-hail-damage-1.3025475 • Insurance info brochure: http://www.insuranceisevolving.com/files/pdf/cloud-seeding-brochure-final.pdf • Along the TransCanada Highway near Kananaskis there is a billboard entitled "Look Up!!! THERE'S A NEW CLOUD IN TOWN", promoting the belief that Chemtrails are real: lookupbanff.com suggesting that chemicals other than fuel are being purposefully released into the atmosphere by commercial airplanes. • What are the white "trails" behind a commercial airplane? They are known as Contrails, which are the products of hydrocarbon combustion: H2O vapour and CO2 gas. Keep in mind, vapour at high altitudes is cold, so think of vehicle exhaust on a cold day when accelerating. Teacher Resource: https://science-edu.larc.nasa.gov/contrail-edu/science.php and http://www.smithsonianmag.com/smart-news/science-officially-debunks-chemtrails-conspiracy-live-180960139/

Notes:

Lesson # 11: Setting the Stage

Topic:	**Field Study: Data Upload and Discussion of Results**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • explain how various factors influence the size of populations; i.e., immigration and emigration, birth and death rates, food supply, predation, disease, reproductive rate, number of offspring produced, and climate change • describe the relationship between land use practices and altering ecosystems *(e.g., swamp drainage, slash and burn forestry, agriculture)* • trace the development of a technological application that has altered an ecosystem *(e.g., power generation, fishing, logging, oil and gas exploration, agricultural practices)* • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation • Select appropriate methods and tools for collecting data and information to solve problems Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Organize data, using a format that is appropriate to the task or experiment • Select and integrate information from various print and electronic sources • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify strengths and weaknesses of different methods of collecting and displaying data • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork

	Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task • Defend a given position on an issue or problem, based on their findings
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	• Access to computer with a map of data available for students to compare to another biome
Type of lesson	• Compare/contrast and T chart activities • Word Jumble • Case study • Mock Town Hall Meeting **NOTE:** Compare and Contrast sheet found here and Word Jumble Sheet found here
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Scenario: Water supply in Okotoks • Community is running out of water (Sheep River) and is negotiating with the City of Calgary to access treated water from the Bow and then move it via a pipeline to the southern city. Recently the City approved expanding the population by building more houses. Is this a wise idea when there are already concerns about access to water? What would you recommend if people are interested in moving outside of Calgary to smaller communities? • Teacher resources: o https://albertaventure.com/2014/01/future-water-wars-alberta/ o http://www.cbc.ca/news/canada/calgary/okotoks-water-pipeline-1.3809473 o http://www.okotoks.ca/doing-business/public-tenders/potable-water-pipeline-detailed-alignment-consultant
Lesson Sketch	1. Data entry into database (upload video/photo). **Teacher:** check in, to make sure the upload is complete (https://seedsconnections.org/share-about-water) 2. Guided questions to compare/contrast • What do you think will happen if (insert an abiotic factor) is changed in the ecosystem you just visited? Keep it local, based on the data from the water sample analysed. • Students should stay in their lab groups, and compare data with another class from another location in Alberta - preferably a different biome. A map of the 6 natural regions of Alberta is available from Alberta Advanced Education: http://advancededucation.alberta.ca/englishexpress/articles/pdf/ra11_09_l3.pdf • Detailed information about Albert's Grassland Region is contained in the document. Challenge students to find similar information about your region or regions that are dissimilar for comparison of data. • Each group should look at a different set of data to compare to their own. • See the attached *Compare and Contrast Analysis* sheet. 4. Presentation of findings: Each lab group will informally share their findings with the class. See checklist. 5. Write the following terms on the board, or create a Word Wall. Ask students if they recognize or already know what these words mean. In pairs they can write operational definitions based on their current understandings of the words. o Immigration o Emigration o Birth rate o Death rate o Food supply o Predation o Disease o Reproductive rate o # of offspring produced o Climate change

6. Briefly go over each word describing how they change the population (increase vs. decrease). Use your discussion to refine the students' definitions from #5 above.

7. **Word Jumble** (see student sheet here): On a T chart, partners will be asked to sort the above words into two groups using the following headings:
   - *Causes an INCREASE in population*, and *Causes a DECREASE in population*. See attached example.

   - Can any of these factors both increase and decrease? Why? Students may place food supply and climate change on both. Food supply may be interrupted or improve. Climate change may increase agriculture in some northern locations, but decrease in areas close to the equator, or locations that are prone to drought.

8. Reflect on the site where the class collected their water samples. Was it ever disturbed in any way? Are there buildings nearby? A road? Do lawn mowers visit the area? Did you see any garbage/litter? Are there other signs of human or animal activity in the area?
   - Now imagine what a water body would be like in a setting that was different than the one you visited. How might the following settings look?
     - Forest
     - Prairie
     - Tundra
     - Mountains

   - Imagine what a water body would be like with more or less industry in the area, specifically upstream. Consider some of these industries:
     - Oil and gas
     - Paper mill/forestry (such as slash and burn or clearcutting)
     - Agriculture
     - Fishing
     - Municipality (such as draining water before building new neighborhoods)
     - Power plant/ dam

   - Humans use the land in many ways. What is the relationship between land use practices and altering ecosystems? We tend to jump to the negative impacts. Could we think of some positive changes? How might some of these industries improve conditions? As a society, if we value our natural environments, government and industry will put a priority on these things. In Canada, most industries must submit a plan on how they will clean up, or remove and restore the area when they are done BEFORE they are allowed to open. What are some of the positive efforts being made by industries and others to promote and sustain water quality?
   - Can you see yourself working in one of these industries as a career?
   - What worries you in regards to industry and land use?
   - How might you be able to change or improve practices?

9. The construction of the Site C Dam along the Peace River in northern British Columbia is underway. We will trace the development of this technological application that is altering the local ecosystem. It is important because geological features do not respect provincial or national boundaries – decisions made in one area impact other locations as well. For instance, the Peace River flows into Alberta. What are the pros and cons to building dams?

Teacher resource: https://www.sitecproject.com/

- Pros: "Clean" energy, no pollution, etc.
- Cons: human displacement (how vulnerable people are moved off their land such as the Three Gorges Dam on the Yangtze River in China, or the Churchill River in northern Manitoba, compensation to land owners, etc.),
  - Impact on animal on land and in the water
  - Methylmercury: mercury naturally occurs in the soil in a form that is immobile. When saturated, it becomes mobile and toxic to animals that are exposed to it. A dam saturates a large area of soil. The mercury moves into and up the food chain. Follow the food chain to see what plants and animals are affected along the way. Review '**biomagnification**' and '**bioaccumulation**' from Lesson #5.
  - How does pollution change how organisms interact?
  - https://www2.usgs.gov/themes/factsheet/146-00/
  - https://www.epa.gov/mercury/how-people-are-exposed-mercury

10. How can we detect exposure? (Hair, blood, eating fish/organisms from dam etc.)
    - General Dam Resource: https://www.sitecproject.com/
    - A brief overview video (5:16) helps to show what is taking place: https://www.sitecproject.com/news-and-information/project-videos
    - Information sheets from the BC Hydro perspective discuss the: process of interacting with Aboriginal groups; methylmercury concerns; protecting native wildlife; environmental reviews, etc. Information found here: https://www.sitecproject.com/news-and-information/information-sheets
    - Information about how Aboriginal groups challenged the Dam in court and lost their appeal: http://www.cbc.ca/news/canada/british-columbia/federal-court-dismisses-first-nations-challenge-of-site-c-dam-1.3948830
    - Land expropriation from local farmers: http://www.cbc.ca/news/canada/british-columbia/site-c-dam-project-forces-expropriation-of-b-c-family-farm-this-spring-1.3893783
    - Concerns about how this Dam will affect Wood Buffalo National Park, a UNESCO World Heritage Site that the water will pass through: http://www.cbc.ca/news/canada/edmonton/unesco-sees-fort-chipewyan-s-low-water-levels-up-close-1.3785316
    - Fines due to environmental missteps: http://vancouversun.com/business/local-business/bc-hydro-facing-federal-order-heavy-fines-for-site-c-sediment-and-erosion-problems
    - Human rights concerns with Amnesty International: http://globalnews.ca/news/3119627/amnesty-international-takes-aim-at-site-c/

11. Mock Town Hall Meeting: There are many pros/cons and many perspectives to a large development such as the Site C Dam. Students can take on different roles to argue the perspective they have been assigned. Having students who are not assigned a specific role act as local community members who are able to stand up and ask questions (line up at a pretend microphone) at any point during the discussion.
    - Set up a Town Hall Meeting with students. The following resource is very useful for teachers dealing with potential controversial issues: http://csip.cornell.edu/Curriculum_Resources/CSIP/Dudley%26Schneider/Dudley%26Schneider.html
    - Suggested roles:
      - Farmers and landowners that live and work on the banks of the river

	o Laid off oil and gas worker (pipefitter, other trades, etc.) o Local Native reserve member, who use this land in a traditional way (hunt and fish) o Local Politician o Scientist o UNESCO representative o Amnesty International representative o BC Hydro o Recreational hunter and fisher o Environmentalist o Local business owner o Local community members attending the Town Hall to ask questions of all the stakeholders 11. With any industrial development, what happens to ecosystem equilibrium? What is the disturbance over the long run? Are there enough measures in place to reduce environmental harm? How are decisions made when considering all of the perspectives? (Bring the discussion back to the nail demonstration).
Closing ideas	In the southwestern corner of the province of Alberta, on the eastern slopes of the Rocky Mountains, there is another debate underway. The Alberta Government has decided to protect an area known as the Castle Wilderness, and set it aside as a Wildland and Provincial Park. In doing this, recreational users who enjoy camping, off-roading, snowmobiling, picnicking, hunting, fishing and hiking have found themselves on all sides of the debate, and at odds with the government and environmentalists. If this area becomes a park, motorized vehicles such as quads, snowmobiles, and dirt bikes would be banned, along with those who roadside camp and are used to not needing to pay/book/ buy a permit, or reserve a site. It has been argued, that garbage and debris is left, and continued use without designated paths and trails causes great harm to the ground and the water. This area is also known as a HEADWATER. This means that water is at the beginning of its journey, or source for the region. If a headwater is damaged, the water quality and availability, along with habitat will also be affected downriver. These areas are known to be very sensitive and it is difficult to undo any damage. Who should have a say? Should these users be cut out of this area? Is that fair, if they have been doing this for generations? Are all land users causing harm? Does this area need protection? • Castle wilderness/headwaters/: https://albertawilderness.ca/issues/wildlands/areas-of-concern/castle/#parentHorizontalTab2 • CPAWS supports the park, and has many links at the bottom of the page to science, maps, pamphlets, etc.: http://cpaws-southernalberta.org/campaigns/castle • Alberta Government: https://www.albertaparks.ca/albertaparksca/about-us/public-consultations/archives/enhancing-the-protection-of-the-castle-area/ • Alberta Wilderness Association: https://albertawilderness.ca/issues/wildlands/areas-of-concern/castle/ • Science document: http://cpaws-southernalberta.org/upload/CMP_-_EWG_Science_Summary_Oct._26,_2016_(updated_Dec._1,_2016).pdf

Notes:

Lesson # 12: Setting the Stage

Topic:	**Equilibrium: Tipping the Scales**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • describe how interactions among organisms limit populations *(e.g., predation, parasitism, competition)* • - assess the impact of the introduction of exotic species on a specific ecosystem or biome *(e.g., purple loosestrife in western Canadian wetlands, English sparrows in North America, zebra mussels in the Great Lakes)* • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Performing and Recording: Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Carry out procedures, controlling the major variables • Organize data, using a format that is appropriate to the task or experiment • Use tools, technology and apparatus safely Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • State a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

	• Receive, understand and act on the ideas of others • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	-have Smarties, cups, bowls, spoons, and activity cards printed and cut out -preview the video to ensure it works. If not, contact your IT department - Unit review tomorrow
Type of lesson	Discussion Video Activity **-NOTE:** Interactions Among Organisms (Teacher Instructions); (Student Instructions); (Game Cards I); (Game Cards II) There is only one set of game cards, but they are to be printed back to back, so one is the top of the card, and one is the underside of the card.
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Sometimes a disease hitches a ride on a boat when you move your boat from one lake to another. The disease is now spread to the second lake. The same goes for firewood, seeds from flowering weeds, and many other organisms. This could cost the province millions of dollars to try to remove this disease, rather than preventing it from happening in the first place. In this type of situation, places like National Parks may use pesticides to stop the spread of certain unwanted organisms. • Has anyone been stopped on the highway to have their boat checked by a Conservation Officer in Alberta or BC? Why are they doing this? Teacher Resources: o https://www.albertaparks.ca/albertaparksca/science-research/aquatic-invasive-species/ o http://www.cbc.ca/news/canada/british-columbia/invasive-mussels-check-point-vehicle-blew-past-1.3573755 • Sniffer dogs are often used to detect problems. Teacher Resource: https://www.alberta.ca/release.cfm?xID=3790838D33CF4-B115-F96A-5160BAF6737AF90E

Lesson Sketch	1. We have learned about how **abiotic** factors affect populations. Now we will explore how **biotic** factors affect populations. 2. Describe how interactions among organisms limit populations. When does one organism negatively impact another organism? a. **Predation**: hunting another organism for food/territory Video (2:40): https://www.youtube.com/watch?v=CsfJL-IIVz4 b. **Parasitism**: one organism is getting food/shelter from another organism at the cost of the host organism's health. Video (4:43): https://www.youtube.com/watch?v=CsfJL-IIVz4 c. **Competition**: This can be from the same species, or from different species competing for the same source of food/water/territory/mates. Video (1:50): https://www.youtube.com/watch?v=hK8TQQp1qAA d. This video highlights predation, and later shows competitions of resources (3:00): https://www.youtube.com/watch?v=ExV4b77qfww 3. *Interactions Among Organisms Activity* (see below plus Teacher Sheet and Student Sheet; along with Game Cards I and Game Cards II): a. Have a class set of spoons and cups and a handout b. Each group of 3 will need a bowl, a set of cards, and a box of Smarties 4. Discuss competition and predation from the location the water was sampled. What organisms were likely competing? And for what resources? What organisms were likely predators? Draw a simple food chain or food web from some of the organisms identified in the study. Label which were competing for resources, and which were preying on each other. 5. Exotic species introduced in an ecosystem 6. Watch the video (28 minutes): http://thewaterbrothers.ca/carpageddon/ or The *Nature of Things* episode 'Carpe Diem' (45minutes): http://www.cbc.ca/player/play/2410176258 Prediction activity: What do you think will happen to the local ecosystem when the following two exotic species are introduced? 1. Goldfish introduced to local waterways (Red Deer) • Info sheet: http://aep.alberta.ca/fish-wildlife/invasive-species/aquatic-invasive-species/documents/AIS-Quickfacts-PrussianCarp-May2015.pdf • Teacher Resources: http://aep.alberta.ca/fish-wildlife/invasive-species/aquatic-invasive-species/fish.aspx • Drumheller, AB: https://www.drumhelleronline.com/local/14144-invasive-fish-speices-found-in-drumheller-area-bodies-of-water • High River, AB: http://www.huffingtonpost.ca/2015/09/21/southern-alberta-town-hopes-to-rid-storm-ponds-of-invasive-goldfish_n_8161520.html • Bow River, AB: http://calgary.ctvnews.ca/goldfish-and-prussian-carp-threaten-bow-river-s-ecosystem-1.1867792 2. Zebra mussels in the watershed (Lake Winnipeg). • Info sheet: http://www.lakewinnipegfoundation.org/zebra-mussels-101 • http://globalnews.ca/video/2348384/what-zebra-mussels-have-done-to-other-lakes-and-the-damage-potential-for-manitoba • http://globalnews.ca/news/2885661/zebra-mussels-multiplying-in-lake-

	winnipeg-now-found-on-shorelines/ • http://www.cbc.ca/news/canada/manitoba/lake-winnipeg-zebra-mussels-lost-cause-eva-pip-1.3264283
Closing ideas	Case study: Whirling Disease has been discovered in Banff and the Bow River that eventually joins up with the Old Man River near Medicine Hat and flows into the South Saskatchewan River that eventually drains into the Hudson Bay (http://www.southsaskriverstewards.ca/the-south-saskatchewan-river-basin.html) This disease can kill trout when infected. There are several trout species, such as Bull Trout and Cutthroat Trout that are already at risk, due to other sensitivities. • Banff National Park will kill fish in some lakes to protect the fish downstream: http://www.cbc.ca/news/canada/calgary/whirling-disease-johnson-lake-banff-cutthroat-westslope-parks-canada-two-jack-1.4119302 • Canada: http://www.inspection.gc.ca/animals/aquatic-animals/diseases/reportable/whirling-disease/fact-sheet/eng/1336686597267/1336686806593 • Alberta Environment: http://aep.alberta.ca/fish-wildlife/wildlife-diseases/whirling-disease/default.aspx

Notes:

Lesson # 13: Setting the Stage

Topic:	**Field Study: Review and Reflect**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium • https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Initiating and Planning: Ask questions about relationships between and among observable variables and plan investigations to address those questions • Identify questions to investigate arising from practical problems and issues • Define questions and problems to facilitate investigation Analyzing and Interpreting Analyze qualitative and quantitative data, and develop and assess possible explanations • Identify strengths and weaknesses of different methods of collecting and displaying data apply given criteria for evaluating evidence and sources of information • State a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea • Identify and evaluate potential applications of findings • Identify new questions and problems that arise from what was learned Communication and Teamwork Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means • Evaluate individual and group processes used in planning, problem solving, decision making and completing a task • Defend a given position on an issue or problem, based on their findings

Attitudes	Most of the Attitude Outcomes stated in the Program of Studies are included into each of the *Wading in for Water* lessons. This includes; Interest in Science, Mutual Respect, Scientific Inquiry, Collaboration, Stewardship, and Safety. Please refer to the specific outcomes · https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Planning ahead	Unit assessment next class
Type of lesson	Wrap up and review class
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: Question: How many of you have washed your family vehicle/bike/toys/driveway/anything with soap and water outside your home? Where does the water go? Is this different than the drain in your shower? • When water goes down the storm drain, it does go directly into the local river without being treated. This means that soap and other extra dirt is flushed into the river without being cleaned or treated first. Conversely, the water that goes down the shower drain goes to the water treatment plant to get cleaned before being released back into the local river. • Video (1:41): https://emeraldfoundation.ca/aef_awards/yellow-fish-road-2/ • Teacher resource: http://tucanada.org/yellow-fish-road/ Did you know that in many cities, it is a city bylaw that you cannot use soap to wash your vehicle? http://www.calgary.ca/CSPS/ABS/Pages/Frequently-asked-questions/Sewers-drainage.aspx Fines: http://www.cbc.ca/news/canada/calgary/driveway-car-washers-face-3-000-fine-1.849197
Lesson Sketch	1. Round table discussion: Field Study Reflection • What would you include/change about this study if you could do it again? • How could the project be improved? • How can we be certain about our results? How do we know we were accurate in collecting our data? • As a group, did you work well together? Could the roles be improved? • How could you have dealt with someone who did not pull their weight? • What did you do when you didn't agree with someone? Ecosystem • Is the aquatic ecosystem we studied "safe"? Explain. How should we define "safe"? • Did the data show the water to be more/less safe than the place you compared to? How could you tell? • What are your concerns about this ecosystem? What are you happy with? Explain. • Should industry or government be managing water in Alberta? Defend your answer. • What can we learn if we study water in the same location over the long term? • Do you think our data is useful today? In the long term? 2. Unit review activity and revisit the Word Wall.

	3. Prepare for a unit assessment next class.

Closing ideas	What role can citizens like us play in collecting data for scientific/environmental monitoring? Find out about other 'citizen scientist' projects:
	• Everyday citizens can contribute to data collection that is important to long term studying of water, wildlife, etc. Check out some "citizen scientist" sites:
	  • http://naturealberta.ca/programs/birds-biodiversity/citizen-science-database/
	  • http://aep.alberta.ca/about-us/special-weeks/environment-week/documents/CitizenSciencePrograms-Mar2013.pdf
	  • http://scienceoutreach.ab.ca/resources/citizen-science.php
	  • http://albertawater.com/alberta-water-blog/2829-citizen-science-here-s-your-chance-to-make-a-difference-by-mike-kelly
	  • http://www.davidsuzuki.org/what-you-can-do/citizen-science/
	  • https://www.cleanwaterbirthdayproject.com/

Notes:

Lesson # 14: Setting the Stage

Topic:	**Unit Assessment**
Science 14 Program of Studies outcome(s): Science, Technology and Society (STS) and Knowledge	Students will: 1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium https://education.alberta.ca/media/3069383/pos_science_14_24.pdf
Skills	Assessment
Attitudes	Assessment (anecdotal; checklist; etc.)
Planning ahead	Unit D is complete at the end of this lesson / ENS 3910 Project follows
Type of lesson	Assessment
Word Wall	Listed in Appendix A

Getting Started

Topic opener "hooks"	Intro/ Hook ideas: • Unit review with the class • Go over the Word Wall • Discuss the larger concepts.
Lesson Sketch	Unit assessment – Teacher Developed
Closing ideas	• Mark the test (teacher or together in class) • Go over answers once complete

Notes:

Career and Technology Studies ENS Project D
Wading in for Water Action Project

Long Range Planning:

- 100% of ENS 3040, 100% of ENS 3910, ~20% ENS 3050
- ~ 20 hours
- Consists of 9 lessons (varying from one class to three classes for a total of 12-15 classes) and the implementation of the action project where applicable.
- Additional materials will be made available for the completion of ENS 3050 (which will involve additional hours) as the credits for ENS 3910 are dependent on the completion of both ENS 3040 and ENS 3050.

Documents Included with this Project Plan (links provided)

- Project Proposal Sheet (supporting document)
- Project Planning Template (supporting document)
- WebQuest Presentation Sample: https://seedsconnections.org/resources
- Project Rubric (supporting document)

Links required/recommended:

- WebQuest Site: https://seedsconnections.org/webquest-student-introduction

SEEDS Connections *Wading in for Water* Action Project

Career and Technology Studies Curricular Connections

Project Course Code:	Project Course Title:
ENS 3910-Project D	**SEEDS Connections Wading in for Water Action Project**

CTS course connections and the year the credits were or will be awarded.

CTS courses that the project course connects with (minimum 2)	When the credits were or will be awarded	Occupational Area(s)
CTS advanced course ENS 3040: ENERGY & THE ENVIRONMENT	**Credits will be awarded for** ENS 3910 will be awarded at the same time as ENS 3040.	**Environmental Stewardship (ENS)**
CTS advanced course ENS 3050: ENVIRONMENTAL POLITICS	**Credits will be awarded for** ENS 3910 will be awarded at the same time as ENS 3050	**Environmental Stewardship (ENS)**

Project Description

Students will conduct a field study of a waterway in their community. They will collect multiple samples from multiple sites. Upon completion of their data collection, they will analyze the water quality of the ecosystem and determine factors that might contribute to the overall function of the system. They can then compare the water quality of this system to another in Alberta using a resource such as http://www.riverwatch.ab.ca/science/data. Once they have completed their analysis, students will design a plan for personal and community–based strategies to address aquatic water quality that considers environmental, social, political, economic and technological factors.

What are the attitudes, skills and knowledge that will be enhanced and extended by completing this project?

Students will develop a personal and community action project that addresses the key findings from their aquatic field study. The purpose of this project is to determine ways to maintain or improve water quality in their study area. The project will improve student understanding of water conservation issues,

develop students' leadership skills, team work skills, group management abilities, and improve their understanding of the complex environmental, political, social, and economic factors that must be considered with regard to the health of their local waterways.

What are the safety concerns for this project?

The safety concerns for the action project are dependent on the actions students choose to pursue. Exploration and acknowledgement of these concerns will be an important step of project planning and are included on the project planning template.

What will be needed to accomplish this project (e.g., tools, materials, money, people, time)?

The requirements for project completion will differ from project to project depending on the actions students choose to pursue. Exploration and acknowledgement of these requirements will be an important step of project planning and are included on the project planning template.

Relevant CTS Course Connections

Connected courses	Outcomes being linked
ENS 3040: Energy and the Environment	**Outcome** 1. Describe the social, economic and environmental significance of energy development 1.1 describe the social, economic and environmental significance of an energy development; e.g., a hydro dam (Brazeau and Bighorn dams), windfarms (Pincher Creek), coal or gas fired power plant (Keephills) 1.2 analyze the relationship between an energy development and the environment; e.g., greenhouse gases, acid deposition, ecosystem destruction, resource depletion, ozone depletion, smog, water pollution

	1.3 describe actions taken by industry to reduce or eliminate the environmental impacts of an energy development; e.g., development practices, reclamation technologies, environmental monitoring procedures, capture and recovery technologies 1.4 evaluate government policy and regulation at provincial and national levels intended to respond to social, economic and environmental concerns regarding an energy development; e.g., royalty legislation, Kyoto Protocol, Montreal Protocol, land-use policies, environmental legislation 1.5 describe public consultation and consensus procedures that respond to social, economic and environmental concerns; e.g., town hall meetings, round table discussions, focus group discussions
	Outcome 2. Plan and implement a strategy for personal action that promotes an environmentally sustainable lifestyle 2.1 conduct a personal energy audit; e.g., maintain a log, chart or graph of personal energy use 2.2 identify personal needs and wants based on the energy audit 2.3 evaluate the impact of your personal energy use and lifestyle factors on the environment 2.4 describe and implement a strategy that enables an environmentally sustainable lifestyle 2.5 evaluate the social, economic and environmental consequences of implementing your strategy

2.6 revise your strategy according to environmental, social and economic outcomes

Outcome

3. Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community

3.1 identify and assess opportunities for reducing the environmental impacts of energy use within the classroom, school and/or community; e.g., conduct a cost-benefit analysis of an energy-saving technology and/or activity

3.2 identify potential obstacles to group action aimed at reducing environmental impacts

3.3 plan and implement a classroom, school and/or community campaign that promotes environmental awareness and energy conservation; e.g., develop a marketing campaign to increase public awareness

3.4 identify constructive ways in which individuals can influence group decisions that affect energy consumption and the environment; e.g., voting, lobbying, seeking office, supporting compatible interest groups

3.5 design a social, economic and/or environmental impact assessment and consultation process for a proposed energy project

Outcome

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:

4.1.1 communicate
4.1.2 manage information
4.1.3 use numbers
4.1.4 think and solve problems

	4.2 demonstrate personal management skills to: 4.2.1 demonstrate positive attitudes and behaviours 4.2.2 be responsible 4.2.3 be adaptable 4.2.4 learn continuously 4.2.5 work safely 4.3 demonstrate teamwork skills to: 4.3.1 work with others 4.3.2 participate in projects and tasks
	Outcome 5. create a transitional strategy to accommodate personal changes and build personal values 5.1 identify short-term and long-term goals 5.2 identify steps to achieve goals
Course Name and Code **ENS 3050: Environmental Politics**	**Outcome** 2. analyze challenges in developing, influencing and implementing environmental policies 2.1 identify how government structure affects developing, influencing and implementing environmental policies 2.2 describe a variety of principles that guide the development and implementation of environmental policies; e.g., humility principle, precautionary principle, public participation principle, human rights principles, environmental justice principle 2.3 assess the impact of individual actions on developing and implementing environmental policy

	2.4 investigate trends in the structure of organizations (e.g., businesses, governments, NGOs) that positively affect the development and implementation of environmental policies 3. assess the impact of the legal system in developing, influencing and implementing
Other Potential Connections to courses and outcomes* **Relevant only if students already have earned these credits previously, as all courses listed below have prerequisites that are required before completion.**	
ENS 2120 Water Management I	Relates to all curricular outcomes
ENS 2130: Renewable and Non-renewable Energy Resources	2. analyze the potential environmental and economic impacts of a variety of current and future renewable and non-renewable energy sources (e.g., conventional oil, oil sands, hydrogen, direct solar, hydro, nuclear, wind, geothermal, biomass, waste, biofuels), considering but not limited to: • net energy and/or energy returned on energy invested (EROEI) • availability of source • cost to develop, phase in and use • governmental incentives • national and global economic and political security • facilities and equipment essential to energy production • basic steps, including safety measures, involved in energy production • effects of extraction, transportation and use on the environment
ENS 3110: Integrated Resource Management	1. describe basic principles of resource management 1.1 describe principles of supply-side resource management and demand-side resource management by citing examples of each within Alberta 1.2 compare principles of integrated land use with principles of multiple use management by citing examples of each within Alberta 1.3 explain sustainable development and resource management within the context of Alberta's natural resources

	1.4 examine local opportunities for consultation and public involvement in resource management decisions; e.g., community associations, industry, local government, provincial departments and/or agencies
	2. describe government legislation and policies that influence the development of a natural resource 2.1 explain the mandate and responsibilities of key government departments and agencies in managing natural resources within provincial boundaries; e.g., disposition of mineral rights, regulation of exploration and development, development of conservation practices and environmental standards, collection of fair returns from resource development 2.2 explain current and potential opportunities for industry, NGO and public interest group involvement in managing natural resources within provincial boundaries 2.3 examine the role of important federal and provincial legislation in managing exploration and development activities within one of Alberta's natural resource industries 2.4 evaluate the short- and long-term effects of one or more government legislations and regulations on one of Alberta's natural resources
ENS 3120: Water Management II	Relates to all curricular outcomes
ENS 3130: Sustainable Energy	2.identify issues involving current and future energy supply and demand 2.1 describe recent applications of technology in renewable and non-renewable energy development; e.g., technologies designed to improve production and lessen environmental impacts 2.2 examine social, economic and environmental perspectives regarding renewable and non-renewable energy supply; e.g., trends in energy conservation, efficiency and lifestyle choices

	2.3 describe applications of renewable energy in reducing demand on non-renewable energy sources; e.g., domestic and industrial heating, transportation 2.4 research forecasts regarding future energy supply and demand and options for ensuring a sustainable energy future
	5. present a plan for sustainable energy development 5.1 provide a definition and examples of sustainable energy development 5.2 compare the roles of renewable and non-renewable technologies in sustainable energy development 5.3 cite examples of sustainable energy path development that involve least-cost combinations and efficient use of both renewable and non-renewable energy sources, considering that sustainable energy path development involves matching the “quality” of the energy provided to the “quality” of the energy required 5.4 suggest a rationale for sustainable energy development that addresses social, economic and environmental perspectives 5.5 propose changes to current social values and political structures that may facilitate sustainable energy development; e.g., consumer practices, government policy, technology 5.6 develop and present a plan for sustainable energy path development that includes supply-side management solutions and demand-side management solutions 5.7 evaluate the plan on the basis of predicted social, economic and environmental consequences

What will be accomplished by linking these outcomes in this project?

Through the *Wading in for Water Action Project*, students will have the opportunity to analyze and evaluate the effects of various types of development on the quality of their aquatic ecosystems. The project will have students focus on how various economic, environmental, political and technological factors contribute to the quality and sustainability of these ecosystems and consider how these factors can be managed in the most sustainable way. By connecting ENS 3910: Project D to the above mentioned outcomes, students will have the opportunity to explore these outcomes in more depth and put their knowledge and understanding in action. Students will have the opportunity to choose how to address complex societal issues in a meaningful way and feel empowered that they can have a direct impact on issues in their communities (this also has direct connections to the *Science-Technology-Society* foundational statements found in the Alberta Education Science 14 Program of Studies).

Why were these courses and key outcomes chosen?

These outcomes most closely link the Science 14 field study component of our program and the action project.

Lesson #1: Review of Field Study and Discussion of Development Impacts

Time required: One 60-75 minute class period

Setting the Stage	
Topic:	Watershed Activities and Their Impacts
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* *1. Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Whiteboard or Flipchart Paper for Brainstorming • Markers • Computers for Student Research
Type of lesson	Brainstorm Discussion Research
Word Wall	Social Impacts Economic Impacts Environmental Impacts

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: How do human actions affect aquatic ecosystems? - "How Land and Water are Linked" video: http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/water/watershed-protection/agriculture-and-water-quality/how-land-and-water-are-linked-video/?id=1401992196838 - "How Water Gets to Your Home—And Back to the River" video: https://www.youtube.com/watch?v=Msqu4cAQ76U
Lesson Sketch	
Outline	1. Brainstorm Questions: Review the results of the field study. What did we learn about our watershed? 2. Discuss: Human impacts on the environment and local activities that might affect the aquatic ecosystem. a. Create a table with the following headings: *Urban and Suburban Development, Energy Projects and Resource Extraction, Agriculture* b. As a class, in groups or independently have students brainstorm all activities that they know are happening upstream of the field study site and place each activity under one of the headings in your table. If possible, include at least one energy/resource development project.* *Students could be given some time to research these activities if this is considered necessary. c. As a class or in a group, decide which 3-5 activities students believe have the most potential to affect the quality of the water at their field study site. Resources and Links: http://albertawater.com/water-maps-Watershed mapping https://rivers.alberta.ca/ https://www.studentenergy.org : The "Energy Systems Map" provides a graphic representation of renewable and non- renewable energy sources. Can help students understand the various ways that resources are extracted and used. The "Production and Conversion" page provides definitions of various

energy production and conversion methods and includes the potential environmental impacts of these industries

http://majorprojects.alberta.ca/ - Interactive and up to date map of all major projects in Alberta valued at $5 million or more. You can use this combined with the watershed map to determine what will affect your aquatic ecosystem. A note about this resource. This is proposed and under construction projects. In order for the project to affect your watershed it would have to be under construction. Even then it would not be the industry itself that is affecting your study site but rather the construction of that project.

http://seedsconnections.org/energy-literacy-series - The virtual map in particular will help you to see the ten different kinds of energy development and where in Canada they are being used.

http://www.greenlearning.ca/programs/ - The programs page has links to lots of information at the provincial and the federal level about a variety of types of development

http://resources4rethinking.ca/ - An in-depth resource database about sustainable development

d. Once you have listed all of the activities above, brainstorm in a group, as a class, or on your own the potential societal, environmental, and economic impacts of each of the activities and fill in the chart below. You can use the links from above to help you.

Activity/Impact	Societal	Environmental	Economic
1.			
2.			

	3. | | | | 4. | | | | 5 | | | |
Closing Ideas	
Closing Question for Consideration	Leave students with the following question, with particular attention to be paid the environmental impacts of development: ***Which of the activities that you have listed has the most impact on the aquatic ecosystem that you have studied?*** This is where lesson two will begin.

Notes:

Lesson #2: Major Activities and Their Impacts

Time required: One 60-75 minute class period

Setting the Stage	
Topic:	Watershed Activities and Their Impacts
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* *1. Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Whiteboard or Flipchart Paper for Brainstorming • Markers • Computers for Student Research
Type of lesson	Brainstorm Discussion Research
Word Wall	Agricultural Impacts Energy Projects Resource Extraction Urban and Suburban Development

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: "Oil Sands at a Crossroads" is an investigative report on the economic and environmental issues at play in the Alberta Oil Sands: (https://www.youtube.com/watch?v=LsyEnkb0Gn0 : 0:00 to 8:30) Where resource development is an issue upstream of the study site, this video can help introduce the topic.
Lesson Sketch	
Outline	1. Review the question for consideration that was posed at the end of lesson one: ***Which of the activities that you have listed has the most impact on the aquatic ecosystem that you have studied?*** a. Restate the question by writing it on the board. b. Have students spend ~5 minutes on their own picking the activity that they believe had the most impact on the study site and justifying their choice. This can be written down or not. Emphasize students to go with their gut instinct, as they will have the chance to do more research in the coming lessons. c. Divide the class into groups of 3-4 so that they can share their opinions and designate a recorder d. Students will spend 5-10 minutes discussing their choices in groups while one student records the conversation. e. Students will then discuss what they think they need to know about development activities in order to have a better understanding of the potential impacts. This can be done as a short discussion in small groups and then should be extended to a larger class discussion where the teacher can probe and assist students to consider more in depth questions.
Closing Ideas	
Preparation for the Next Lesson	Video: How the Alberta Government Monitors Water. https://www.youtube.com/watch?v=eF7wgHk3H08 Government legislation is a part of their project as is Hydrology. This video will give an introduction to both.

Notes:

Lesson #3: Project Introduction

Time required: Two 60-75 minute class periods

Setting the Stage	
Topic:	WebQuest Introduction and Explanation
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Computer with Internet Access and Projector for Teacher • WebQuest link: https://seedsconnections.org/webquest-student-information • Computers for Student Research
Type of lesson	Discussion Research
Word Wall	WebQuest Action Project Legislation Govern

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: Hydrologist Job: https://www.youtube.com/watch?v=Uvp2AOMYWPM This video is about a forest hydrologist. Show students the video and then discuss what a Hydrologist might do to gather information on your study site and what they could do with that information. Consider how their data may be used by the government and industry to make decisions about water. Then introduce the project.
Lesson Sketch	
Outline	1. Teacher led project introduction: a. Open up the WebQuest (https://seedsconnections.org/webquest-student-information) for students and walk them through the website as a class, explaining what their role is and what is expected of them for their project including completion of the scavenger hunt and a presentation (PowerPoint, Prezi, video, etc.). b. Pay particular attention to the resources that are available to them to assist with their task and explain what the final product will be. Resources and links can be found throughout the WebQuest but particularly under the following pages: Agricultural Impacts, Energy Projects and Resource Extraction, Urban and Suburban Development, Resources c. Once the project has been explained, have students divide into smaller groups and login to computers. 2. Group/ Independent introductory research: a. Before students begin the WebQuest, have all groups complete the following questions to the best of their ability. Students will first need to research the significant impacts of the actions that the group has chosen before they can determine what needs to be done to reduce or maintain the current level of impact this action is having. It is important to discuss with the students that they will not know the answers to some, many, or all of the questions and inform them that this is some of the information that they will be researching and gathering over the course of the project. The purpose of looking at the questions now is to acknowledge or learn what it is that students already know before they begin. i. What are the actions, policies and practices that can reduce the harmful impacts of these activities? ii. How are these actions, policies and practices addressed by the government? iii. Specifically, what legislation governs the industry or activity in question at both the provincial and federal level? How current is this legislation? How effective is it?

iv. What are some of the criticisms of the governments' approach to this issue?

v. How has government legislation supported the responsible development of this activity or industry?

vi. How are these actions, policies and practices addressed by the companies that are operating in your watershed?

vii. How effective have companies been at recognizing and minimizing the effects of their industry on the surrounding environment?

b. This chart will be revisited once students have the opportunity to do some more research:

3. As a class, in a group or independently, students will then consider what each of the following groups does/can do to manage the impact of their chosen activity (they can use the links provided under the following pages: Agricultural Impacts, Energy Projects and Resource Extraction, Urban and Suburban Development, Resources to help them; and/or find some resources of their own)

Group	What to do to manage impact of activity (list as many as you can think of for each group)
You and your community	
Industry (name company applicable) http://www.capp.ca/responsible-development/water	
Federal government	
Provincial government	

4. Students will share their findings thus far with the class including what they are considering for project ideas.

Closing Ideas	
Closing ideas	1. At the end of the two class periods, have groups share their research and project ideas through an informal class discussion or by having each group speak for 2-3 minutes to the class. 2. Restate the project requirements and expectations including the project rubric.

Notes:

Lesson #4: WebQuest Tour and Scavenger Hunt

Time required: One to Two 60-75 minute class period depending on class' understanding and speed

Setting the Stage	
Topic:	Baseline Information Gathering for Action Project
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Student Scavenger Hunt Sheets • Scavenger Hunt Teacher's Key • Computers for Student Research
Type of lesson	Worksheet Research

Lesson Sketch	
Outline	1. Complete WebQuest Scavenger Hunts as individuals or in pairs: a. Hand out Scavenger Hunt worksheets to students. b. Have students login to computers. They can work in pairs or on their own for this activity. c. Direct students to WebQuest Process Page: https://seedsconnections.org/action-project-process d. Give Students 45 minutes to collect the information for the Scavenger Hunt. This information will help students to understand the potential impacts that various activities can have on the field study site. e. Be sure to reserve enough time at the end of the class to go over answers.
Closing ideas	Go over each of the answers to the scavenger hunt to ensure student understanding.

Notes:

Lesson #5: Beginning of Action Project

Time required: One to Two 60-75 minute class periods depending on class understanding and speed

Topic Opener	
Topic:	Field Study Results and Explanations
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Student Scavenger Hunt Sheets (Not needed but will be helpful to guide student research) • Scavenger Hunt Teacher's Key (see note above) • Computers for Student Research
Type of lesson	Group Work Research

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: There is no particular hook for this lesson, though it will be helpful to remind students of the task that they are set to complete and the goals for today's lesson by referring to the task page of the WebQuest (https://seedsconnections.org/individual-or-group-task) "The Alberta Government is interested in developing a campaign or plan to improve the water quality in your watershed. They have hired your team of Hydrologists to research the various factors contributing to water quality in your watershed and to develop an action plan targeted at, what your team deems to be, the most impactful activity on the study site. Your team will create a presentation that: • highlights the key findings from your aquatic field study • identifies and explains the most impactful activities on this site • outlines a plan for addressing the most impactful activities in a positive way that includes a timeline for implementation where possible • has a list of references used for research" As this is a multi-day project with a few tasks to hand in, it would be helpful to give students a benchmark for what they are to complete each day at the beginning of each lesson as well. This is going to change from class to class depending on your students.
Lesson Sketch	
Outline	1. Begin Action Project a. Restate the purpose of the project as outlined above. b. Have students login to computers and direct them to the WebQuest site: https://seedsconnections.org/webquest-student-information c. Show students where they can open and save the PowerPoint document [see SAMPLE Presentation *Wading in for Water* CTS Project: (https://seedsconnections.org/resources)]that contains all of the information that they need to include in their presentation. Note: They do not need to use the format but the presentation does contain all of the information that is expected to be covered in their action project d. Use this document to set a goal for the lesson. Suggest completing the following pages from the SAMPLE Presentation and then starting the research on what the impacts of their chosen activity are:

	i) Title Page ii) Project Introduction iii) Field Study Data iv) Explanation of Field Study Results v) Upstream Activities Sample Presentation: https://seedsconnections.org/resources
Closing ideas	Check in at the end of class for clarification and resetting expectations if they need more time. Time required to complete this task will vary greatly depending on grade level, understanding and speed of students.

Notes:

Lesson #6: Research and Planning

Time required: Two to Four 60-75 minute class periods depending on class understanding and speed

Topic Opener	
Topic:	Researching and Developing an Action Plan for Change
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Whiteboard or Flipchart Paper for Brainstorming • Markers • Computers for Student Research
Type of lesson	Brainstorm Group Work Research

<table>
<tr><th colspan="2">Getting Started</th></tr>
<tr><td>Topic opener “hooks”</td><td>Intro/ Hook ideas:
Brainstorm possible project ideas with students as they are about to begin the “action” part of their work.

Some examples of projects: a campaign to educate the community about the use of lawn pesticides, going into elementary school classrooms to talk about the water cycle and where our water comes from, growing organic vegetables at school and creating a bulletin board to explain why students are doing it, having a guest speaker come in from local industry to explain what their company does to protect water, become “Yellow Fish Road” volunteers: http://tucanada.org/yellow-fish-road/

Students can approach this work in one of two ways:
1. Design a project and carry it out if it is at the scope and scale that this is possible (for example: a class project where they put up ‘did you know” water facts bulletin boards in the school or work with younger grades to share the information that they have gained through their work);
2. Design a strategy that would be carried out by the government such as a campaign to reduce pesticide use in urban and suburban environments. Students will need to explicitly explain the steps required in this case as they will not be carrying out the plan themselves</td></tr>
<tr><th colspan="2">Lesson Sketch</th></tr>
<tr><td>Outline</td><td>1. Brainstorm of potential project ideas:

a. Start with a class brainstorm of projects ideas. You can do this any number of ways. There is an example of a brainstorming process below:

As a class, make a list of the activities that student groups have chosen as the most impactful or important

Refer back to the activity that the class did in Lesson #3 (see chart below). Probe students to turn their answers from this chart into project ideas and write all of the possible ideas on the board.

<table><tr><td>Group</td><td>What to do to manage impact of activity (list as many as you can think of for each group)</td></tr></table></td></tr>
</table>

You and your community	
Industry (name company applicable) http://www.capp.ca/responsible-development/water	
Federal government	
Provincial government	

b. Discuss as a class, which projects they are interested in then give groups a specified amount of time to decide what project they will pursue (15 minutes - they have already had an initial discussion about their ideas)

Project Examples and Ideas:
http://seedsconnections.org/be-change-projects

https://tc2.ca/uploads/PDFs/Social Action Projects/IA_Handbook_5-8_EN_FINAL.pdf

https://takeactionmanitoba.org/category/action-project-examples/

http://www.tigurl.org/images/tiged/docs/activities/1409.pdf

http://lsf-lst.ca/en/projects/teacher-resources/action-programs-youth/eco-league/action-projects

2. Project Work Time:
   a. Again, remind students of their roles as government advisors and set a goal for the day. Suggest completing the following pages from the SAMPLE Presentation and then starting the project plan:
      i. Impact of Upstream Activities
      ii. Most Impactful Activity on [site name]

Closing ideas	Check in with each group and readjust timelines to suit students' abilities and needs.

Notes:

Lesson #7: Action Plan

Time required: Two to Four 60-75 minute class periods depending on class understanding and speed

Topic Opener	
Topic:	Creating a Plan of Action
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	• Whiteboard or Flipchart Paper for Brainstorming • Markers • Computers for Student Research • Projector
Type of lesson	Discussion Research Student-led Inquiry

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: To get students motivated and interested in their action project show one or two samples of Action Projects from other student activist programs. Here are a few examples from the "Be the Change" Program which is a part of the Connections Program through SEEDS Connections: http://seedsconnections.org/assumption-high http://seedsconnections.org/olds-high-school
Lesson Sketch	
Outline	1. Begin by giving students an overview of the steps involved in planning an action project and having them take notes on the process. Use this overview as an opportunity to discuss what has already been done (List adapted from The Critical Thinking Consortium "Social Action Projects: Making a Difference": https://tc2.ca/uploads/PDFs/Social Action Projects/IA_Handbook_5-8_EN_FINAL.pdf a. Clarify the problem i. Gather information ii. Recognize complexity iii. State the problem b. Agree on a sound solution I. Generate possible solutions II. Short-list options c. Plan an effective course of action I. Implement and evaluate the action II. Manage the project III. Draw closure IV. Evaluate results 2. Introduce supporting resources a. Project Proposal b. Project Planner c. Project Evaluation d. Project Rubric 3. Identify Goals for the lesson: By the end of this lesson, students should be starting the Project Proposal and Project Planner and finishing up their presentation by completing the following pages: i. Plan of Action (multiple pages) ii. References

Closing ideas	* At this stage, students will have a wide variety of projects and activities that they need to complete. The details of each groups' project will determine the amount of class time that is required to complete the process. * To finish the lesson, bring the class back together to determine what the needs of each individual group are and to decide on fixed dates and timelines. * **Note:** It may be advisable to discuss what resources students will need from their teacher to complete the project so that these materials will be available for future working periods

Notes:

There will be two general types of projects that students will be doing, as stated in lesson six:

- At this stage, students may become very passionate about a project idea that does not necessarily address upstream activities on their field study site but is well thought out and DOES address water issues. Use your professional judgement to approve these projects. The point is for students to engage in an action project about water, whatever that might look like is ultimately up to you.

- Students will plan and complete a campaign or action project in their class, school or community. This project will be at a scale that is doable within the time allowed and carried out by students. Student will then present this project to the class and evaluate the work that they have done.

- Students can alternatively plan a theoretical campaign or project that would be intended for government to recommend to industry or carry out themselves. Students will carry out a much more detailed project planner and plan for this campaign and present this to the class and evaluate the planning that they have done. In order for students to do the project this way, it is important that they understand and discuss the provincial and federal laws that govern water in the province and include this in their presentation.

Lesson #8: Project Implementation and Evaluation

Time required: This will vary greatly. Some classes will have days, and some will have no time at all and be expected to implement their project on their own time.

Topic Opener	
Topic:	Carrying Out a Plan of Action
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment Curricular Outcomes: *Students will:* 1. *Describe the social, economic and environmental significance of energy development (Outcomes 1.1-1.4)* 3. *Plan and implement a group action campaign that fosters environmental awareness, energy conservation and energy efficiency; e.g., class, school, community (Outcomes 3.1-3.5)* 4. *Demonstrate basic competencies (Outcomes 4.1-4.3)* ENS 3050: Environmental Politics Curricular Outcomes: *Students will:* *2. analyze challenges in developing, influencing and implementing environmental policies* ENS 3910: Project D
Required Materials	∗ Varies - see note at the end of Lesson 7. • Computers for research and completing presentations
Type of lesson	Student led inquiry and action project

Getting Started	
Topic opener “hooks”	Intro/ Hook ideas: There is no need to draw students into this lesson, as they should have their project proposals ready to go. At the beginning of the class it may be helpful to get the class together to lay out a timeline and review the project requirements if your students tend to require this guidance.
Lesson Sketch	
Outline	• Provide the space, time and support that your students need to complete the work that they have laid out for themselves. At this stage, one on one group support for students would be much more helpful then a group discussion, which will only take time away from student work time. • Where students are completed a class, school, or community campaign, they will be using this time to actively carry out their project. • Where students are proposing a theoretical campaign for the government to impose on industry or carry out themselves, they will use this time to expand their presentation to include more detail about what their campaign would entail and to ensure they are prepared to present to the class. • Once students have completed their projects/project plans, time for project presentations and evaluation would be helpful to bring the project to a close and reflect on learning. Students can be given time to complete the rubric provided (seeing “Project Evaluation” attached) and the class can review what they have learned about water.
Closing ideas	Reassert expectations and timelines and make a plan for presentations and evaluations.

Notes:

Lesson #9: Personal Water Inventory

Time required: One 60-75 minute class period

Setting the Stage	
Topic:	Personal Water Audit
Program of Study Information	Program of Study: Career and Technology Studies Natural Resources Environmental Stewardship Strand Relevant Course(s): ENS 3040: Energy and the Environment 2. Plan and implement a strategy for personal action that promotes an environmentally sustainable lifestyle ENS 3910: Project D
Required Materials	• Whiteboard or Flipchart Paper for Brainstorming • Markers • Computers for Water Footprint Assessment Tool • "Water Audit" student sheets • "Water Audit" teacher resource • Teacher computer for video links
Type of lesson	Brainstorm Discussion Data Collection Action Project
Word Wall	Water Footprint Water Consumption Water Inventory Water Conservation Activism

Getting Started	
Topic opener "hooks"	Intro/ Hook ideas: This video by WWF explains what the "Water Footprint": https://www.youtube.com/watch?v=0_bUzH6T6zU Here is one about actual water consumption: https://www.youtube.com/watch?v=On9WRrFHVjY
Lesson Guide	
Outline	2. Begin with a discussion about water consumption by posing the following questions: f. Visualize your day from the time that you wake until the time that you go to bed. In what ways do you use water each day? g. How many litres of water do you think that you use each day? How do you believe that this compares to the average Canadian? h. What do you think uses the most water in your daily life? 3. Introduce and define two different measures of personal fresh water extraction and consumption: a. ***Personal Water Use***: Freshwater taken from ground or surface water sources to be used by individuals. Examples include water to complete the following daily tasks: toilet flushing, showers, cleaning your home, watering the lawn etc. (adapted from the OECD working definition at: http://www.oecd.org/publications/factbook/34416097.pdf) b. ***Personal Water Footprint***: "The water footprint measures the amount of water used to produce each of the goods and services [a person] use[s]. The water footprint looks at both direct and indirect water use of a process, product, company or sector and includes water consumption and pollution throughout the full production cycle from the supply chain to the end-user." (condensed from the water footprint network at: http://waterfootprint.org/en/water-footprint/what-is-water-footprint/) 4. Once you have had a conversation about what students believe they use and then share the following information: according to the Canadian Department of Environment and Climate Change the average Canadian used 251 litres of water in 2011 (the most recently posted statistics by the federal government). This has dropped almost 100 litres in the past 20 years. (You can discuss how and why if you have time-water metering, low flush toilets, more

efficient fixtures and appliances, etc.) Some estimates (McGill University study) have shown Canadians' personal water use to be as high as approximately 330 litres per day.

The Federal Department of the Environment and Climate Change states that the average Canadian's residential water use is as follows:

- 5% Cleaning
- 10% Kitchen and Drinking
- 20% Laundry
- 30% Toilet
- 35% Bathing and Showering

5. Personal Water Inventory:
   a. Do a quick survey of the class: How long do their showers last? Once you have posed this question, share this: each minute of showering uses approximately 9.5-15 litres of water with a regular showerhead. Each minute of showering using an environmentally friendly/low flow showerhead uses approximately 7.5 to 9.5 litres of water.

   b. Ask students some probing questions about their water use: How do you feel about these numbers? Do they surprise you? Do you think you are an average, a low water user or a heavy water user?

   c. Hand out water inventory sheets and explain task: students are to track their water use for a set length of time. (Note: The longer they track their water use the better the data will be but you will need to strike a balance of how much time you/ students have, how long they will remain interested and how accurate their data will be. A weekend or school week would be good. Choose what works for your class).

   d. Once students have completed their water audit sheets, you will need a computer lab to track results. Have students log onto the computers and walk them through the water footprint calculator here: http://waterfootprint.org/en/resources/interactive-tools/water-footprint-assessment-tool/

6. Discussion of Results and Creation of Action Plan:

Once students return with their water audit sheets, have them sit in small groups to go over their results.

Some questions for consideration:

- Were any of your results surprising to you?
- What consumes the most water in your daily life?
- What would have the biggest impact on your personal water use?
- Name three easy changes that you could make today that would

	reduce your personal water use. • What are some other ways that you could conserve water? List at least ten as a group. • What have you learned about the importance of water through this project?
Closing Ideas	
	This is a lot of information for students to take in. It is important to end with a focus on what students can do to make a difference. With that in mind, here are some resources to end the program. Rainforest Alliance-11 tips for conserving water: http://www.rainforest-alliance.org/articles/11-tips-for-conserving-water.Share this resource with students and discuss the tips. Focus on what students can do themselves such as buying less clothing or shopping at thrift stores. It can be hard for us to imagine having so little access to clean fresh water that we would have to consider turning human waste into clean water but the reality is that according to the United Nations, "783 million people do not have access to clean water and almost 2.5 billion do not have access to adequate sanitation. Six and eight million people die annually from the consequences of disasters and water-related diseases." (http://unwater-archive.stage.gsdh.org/UN-Water/www.unwater.org/water-cooperation-2013//water-cooperation/facts-and-figures/en/) Janicki Bioenergy has been working on this problem. Watch this video and discuss with the class. Janicki Omniprocessor: https://www.youtube.com/watch?v=bVzppWSIFU0. This one is about innovation and the future. It is a good positive finish to the module: http://ingenuitylab.ca/about. You can discuss it or you can show the video and let it sit with students. Roll down for the video.

A Final Thought from Jane Goodall:

"What you do makes a difference, and you have to decide what kind of difference you want to make."

REFERENCES

Alberta Education. (2014). Science 14-24 Program of Studies. Retrieved from https://education.alberta.ca/media/3069383/pos_science_14_24.pdf

Alberta Education. *Career and Technology Studies, Environmental Stewardship Programs of Study*. Retrieved from https://education.alberta.ca/media/160271/ens.pdf

Alberta Education. (2016). *The Guiding Framework for the Design and Development of Kindergarten to Grade 12 Provincial Curriculum (Programs of Study) (The Guiding Framework).* Retrieved from https://education.alberta.ca/media/3575996/curriculum-development-guiding-framework.pdf

Sobel, D. (2004). *Place-based Education: Connecting Classrooms and Communities*. Great Barrington, MA: Orion Society.

APPENDIX A: Word Wall

(Building Disciplinary Literacy)

Lesson 1	Lesson 2	Lesson 3	Lesson 4
Matter	Solute	Food chain	Technology
Energy	Solvent	Food web	Mobius Loop
Flow	Scientific Method	Biosphere	Reduce/Reuse/Recycle
Cycling	Matter cycles	Hydrosphere	Renewable/Non-renewable
Hydrologic cycle	Photosynthesis	Lithosphere	Biodegradable
Groundwater	Respiration	Atmosphere	Pollution
Precipitation	Combustion	Recycling	Innovation
Condensation	Carbon sink	Energy Pyramid	Gasification
Freeze/Melt	Fossil fuel	Producer	Consumerism
Evaporation	Bacteria	Consumer (primary/secondary/tertiary)	
Solid/Liquid/Gas	Decomposer	Energy flows	
Runoff	Legume	Hypothermia	
Transpiration	Renewable		
Upstream/Downstream	DNA		
Particulate Nature of Matter	Carbohydrates		
Conservation of Mass	Lipids		
Surface Tension	Proteins		
Adhesion/Cohesion	Fertilizer		
Dense	Compost		
	Meniscus		
	Mass		
	Molecules		

	Variables		
	Carbon/ Nitrogen/ Oxygen Cycles		

Lesson 5	**Lesson 6**	**Lesson 7**	**Lesson 8**
Consequences	Landscape	Climate	Data collection
Pesticide	Biome	Biodiversity	
DDT	Aquatic Ecosystem	Accuracy	
At Risk	Biotic	Precision	
Watershed	Abiotic	Data sheet	
Nutrients (N-P-K-S)	Field study	Organism	
Eutrophication		Elevation	
Database		Endangered Species	
Monitoring			
Data			
Biomagnification			
Bioaccumulation			
Fertilizer			
Industry			
Fishery			
Potable Water			

Lesson 9	**Lesson 10**	**Lesson 11**	**Lesson 12**
Analysis	Turbidity	Population	Limit
Identification	Pseudoscience	Immigration	Parasitism
	Trophic level	Emigration	Competition
	Equilibrium	Birth/Death rate	Predation

	Quality	Food supply	Exotic species
	Cloud Seeding	Predation	
	Contrail	Disease	
		Reproductive rate	
		Offspring	
		Climate change	
		Town Hall Meeting	

APPENDIX B: Student Roles in Group Work

Teacher Note: The roles listed below can be adjusted and/or combined as needed for the group being taught and the number of students in each group.

You are all team members with different roles. For Your team to be successful, complete our lab correctly and on time, you must work together and listen to each other. For each lab, take on a different role. Remember that all group members must participate with the observations, discussion of the results and answering the questions.

- Student 1, Group Manager: Is responsible for keeping group members on task and reminds them to stay with the group, giving positive feedback to all members, and ensuring that the work is done in the time given. If there are any problems with group members, this person must report to the teacher. All group members must participate in the observations, discussion of results, and answering questions.

- Student 2, Materials Technician: Is responsible for reading over the materials list and understanding what is needed and where. All group members will help in the collection of the materials and measured correctly, but before the lab begins, this person will double check that items are correct, and chemicals measured correctly. Once the lab is over, this person will ensure that all lab members are helping to clean up, and the materials are put away correctly. All group members must participate in the observations, discussion of results, and answering questions.

- Student 3, Safety Coordinator: Is responsible for looking carefully at the materials list and warns group members about any safety issues or concerns. This includes concerns with heat, glass, fooling around, chemicals, and safety equipment, etc. For example: If goggles need to be worn, this person reminds group members to keep them on at all times. Knowing where the MSDS sheets are located, where the broom for broken glass and waste is, and chemical waste disposal locations are important. If something happens, it is this person who reports to the teacher. All group members must participate in the observations, discussion of results, and answering questions.

- Student 4, Procedure Analyst: Is responsible for correctly following the procedure. This member will read the procedure several times (2-3 times), and asks the teacher for clarity if unsure about a step. When the lab begins, this person reads the procedure to the group, and makes sure that the group members are doing exactly what they are supposed to be doing. All group members must participate in the observations, discussion of results, and answering questions.

- Student 5, Data Recorder: Is responsible for writing down the needed information for this lab to be complete. Depending on the lab, this may include the hypothesis, the observed results, and making sure that the questions are answered once they have been discussed by all the group members. This person must double check that all information is complete before the group cleans up or moves to the next lab. All group members must participate in the observations, discussion of results, and answering questions.

APPENDIX C: Microscope Use

Note: Before proceeding with this information, please check with your Science Department, and/or your Science Laboratory Technologist, as there may already be agreed upon procedures in place.

All microscope parts have been underlined in the following microscope use procedure:

1. Review the parts of a microscope.
2. Collect a microscope, by holding it upright with one hand on the base and one hand on the arm. **Warning**: Never hold a microscope with one hand, and sideways/upside down as the ocular lens may fall out and break, or worse.
3. Carefully remove the dust cover, and place it in a location that is easy to keep track of and not in the way.
4. Unwrap the cord, and plug in the microscope and turn on the light source.
5. Ensure that the revolving nosepiece is turned to the lowest power objective lens (usually 4x).
6. Carefully place the glass slide to be viewed under the stage clips (if a wet mount is needed see below).
7. While looking through the ocular lens carefully turn the course adjustment knob until the sample is in focus.
8. If there is a problem, the stage controls may need to be adjusted, so make sure that the sample is in the light.
9. Once the sample is located, carefully move to next objective lens (usually 10x) and use the fine adjustment knob.
10. Once the sample is located, carefully move to the highest power objective lens (usually 40x) and **ONLY** use the fine adjustment knob. Use of the wrong knob may result in the lens or the slide or both breaking.
11. If you have been asked to draw what you see only use a pencil, be sure to record the power you are drawing from, giving your diagram a title, and including what it is, labelling the sample using a ruler, and drawing the sample.
12. Once complete, return the slide to the correct location, turn the objective lens back to the lowest power.
13. Turn off the light source and unplug the microscope.
14. Wrap the cord, and put the dust cover back on the microscope.
15. Using two hands, hold the microscope by the arm and the base and return it to the location that you got it from.

Wet Mount:

1. Collect a clean rectangular slide, by holding the edges of the glass and avoiding fingerprints.
2. Using tweezers, place a thin sample onto the slide and one drop of water using an eyedropper.
3. Carefully pick up a square coverslip and hold it at 45 degrees from the slide. Slowly lower one side of the coverslip down on top of the slide, to ensure there are no bubbles.
4. If a stain is needed for contrast, use an eyedropper to put one drop of the provided stain on one edge of the coverslip.

5. Hold a piece of paper towel on the other side of the coverslip, to pull the stain through the sample. This will also help remove excess liquid on the slide.
6. View your sample starting with the lowest objective lens.
7. Carefully rinse off the coverslip and slide, and return both for reuse. If one breaks, be sure to alert the teacher, and to sweep up the glass and place it into the glass disposal.

APPENDIX D: Field Study Materials/Equipment

Equipment List for the outdoor portion of this project

General:

- Bug spray
- Sunscreen
- Hat
- Old, durable shoes/ rubber boots
- Durable clothing/ change of clothes for later

Safety:

- First aid kit
- Cell phone with numbers to school
- Do students have
    - insect allergies? [Epipen]
    - Asthma? [Inhaler]
    - other?

Each group:

- Clip board
- Pencil
- Data sheet
- pH meter/strips
- Dissolved oxygen kit
- Thermometer
- Wind speed meter
- Clean, empty vial with a lid. ~100 ml (for microscopy work and water chemistry kits
- Net to collect aquatic plants/animals
    - Small vial for samples
- ~2 self-closing plastic bags for collection of plant leaves. Note: be careful not to collect the entire plant. A photo of the plant, and a few details of height, berries, flower colour etc.
- Other

Equipment List for the indoor portion of this project

- Water chemistry kits
  - Nitrogen kit *depending on availability at the school*
  - Phosphorous kit *depending on availability at the school*
  - Magnesium kit *depending on availability at the school*
  - Hardness kit *depending on availability at the school*

- Microscope
  - Iodine or other type of stain
  - Eye droppers
  - Cover slip
  - Slide
  - Identification page with common microscopic organisms

- Identification books
  - Plant
  - animal/bird/mammal
- Other

APPENDIX E:

WADING IN FOR WATER PROJECT PROPOSAL

After the initial brainstorm for project ideas, fill out this brief form for approval by your teacher before you move forward.

DESCRIBE THE PROPOSED PROJECT

Proposed Date(s) for Completion

Location (check):

- ☐ Classroom
- ☐ School Common Space (Specify:_____)
- ☐ Community Space *for example Community Centre or Park* (Specify: _____)
- ☐ Other (Specify: _____)

How many supervisors will the project require? _____

Who is involved? Specify what teachers, staff, and community members you want to involve if any.

How will your project affect water quality or awareness about water issues in your community?

Are there any other intended outcomes for the project such as a monetary goals or another ideological purpose not already mentioned?

Who is on the student planning team and what are their roles?

Budget

How much will it cost?

How will you get the funding?

Advertising

How will you advertise this project?

Who is responsible for this advertising?

<u>Approval:</u> Y/N (comments)

APPENDIX F:

***Wading in for Water* Action Project**

ENS 3910: Project Planning Template

Use the space below to plan and provide the details of your project. These details can be in point form. Be prepared to explain to your teacher and peers what you are going to do in more detail.

Expand on your project proposal by answering the following questions.

Describe your project

Is your action project focused on:

- ☐ water awareness
- ☐ water conservation
- ☐ reduction of water use
- ☐ other (explain)_____

Is your action project a:

- ☐ class action
- ☐ school wide action
- ☐ community action,
- ☐ other (explain)_____

In a brief paragraph, describe you would like to do for your action project including what actions you would like to take and how these actions relate to maintaining or improving water quality in your local watershed.

Proposed Project Date: _____ Proposed Project Location: _____

Is there a process in your school for getting approval for such projects? Who do you need to get approval from and who is going to do this?

To Do List

For the next section, fill out all of the information that is related to your project. Brainstorm with your teacher, classmates, or group members to make sure that nothing is missed. At the end of this section you will make a detailed 'to do' list from this information that includes who is responsible, for what, and completion dates for each component. Make sure that everyone in your group helps to complete this list and is aware of their responsibilities and deadlines. Post it somewhere in your classroom so that everyone can see it.

Materials Required

List all materials that need to be bought/borrowed/picked up/donated and include who is responsible for each item. State whether the item needs to be bought/borrowed/acquired/picked up/donated.

Item	Bought/Borrowed/ Brought from Home/ Picked Up/Donated	Person Responsible	Cost (Where Applicable)	Date Needed
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18				
19.				
20.				

Fundraising

Do you need to fundraise for the event? Y/N If so, describe your fundraising strategies below.

Monetary Goal :
Who is responsible for the fundraising? _____
_____

Attach fundraising schedule if necessary.

Supervision

How many supervisors do you need for this event? _____
Who is responsible for contacting supervisors? _____

Who are your supervisors?

TEACHER'S NAME	Check here when you have confirmed that they will attend.

What other permissions do you need? *(for example: do you need to ask your principal before you run an event or do you need to talk to the physical education department before you use the gym?)*

PERMISSION REQUIRED	TEACHER'S NAME	Check here when you have confirmed permission.

Venue

Who is responsible for confirming the space needed? _____
Have you confirmed that the space you need is available? _____
What space is this? _____
Who did you confirm with? _____

Signups/pledges

Does this event require signups or pledges? Y / N (circle one)
If so who is responsible for this? _____

Describe what needs to be done:

Advertising

Types of advertising (check the ones you are using and state who is responsible for it)

Type of advertising	Person Responsible
School/Community Bulletin	
Other School Social Media	
Posters	
Facebook	
Twitter	
School Calendar	
Word of Mouth	
Other	

Official Event Photographer/Media Organizer: _____

Guest Speakers

Are there any guest speakers? If there are more than fit in this space attach a list.

Names	Cost	Who will contact the speaker?	Check when the speaker is confirmed

Sponsorship/Sponsors

Are there sponsors for this event? List all sponsors below. If you are contacting sponsors you may require a sponsorship letter. Please attach the sponsorship letter to this plan.

Timeline for completion

For each item on your 'to do' list provide a completion date. Check this off when it is done and list the date that you actually completed it.

Item to Complete	Person Responsible	Completion Deadline	Complete (✓) – Date completed

APPENDIX G:

Wading in for Water Project Rubric

This is to be completed individually by students at the end of their project. Students are encouraged to expand on the reasoning behind each criterion and give specific examples of how the outcomes were met. Teachers can use the same rubric to evaluate student progress during project planning, implementation and evaluation.

Student Name: _____ Teacher: _____

Name of Project: _____ Start Date: _____

Finish Date: _____

Criteria	Excellent	Proficient	Adequate	Limited	Insufficient
Identify the connection between the project course and two or more CTS courses	Give an insightful explanation of connections between field study experience and action project	Give a relevant explanation of connections between field study experience and action project	Give a reasonable explanation of connections between field study experience and action project	Need others to explain details of connections between field study experience and action project	Has not yet provided evidence.

Criteria	Excellent	Proficient	Adequate	Limited	Insufficient
Propose the project	Outline proposal collaboratively with teacher. Take a leading role in the development of proposal; e.g., • prepare detailed project plan that includes purpose, deliverables, timelines, terms and resources • identify health and safety standards • define assessment standards (indicators of success) • obtain approval.	Review proposal by teacher. Take a role in the development of proposal; e.g., • prepare detailed project plan that includes purpose, deliverables, timelines, terms and resources • identify health and safety standards • define assessment standards (indicators of success) • obtain approval.	Review proposal by teacher. Take a minimal role in the development of proposal; e.g., • prepare detailed project plan that includes purpose, deliverables, timelines, terms and resources • identify health and safety standards • define assessment standards (indicators of success) • obtain approval.	Review proposal by teacher. Listen while others work on the development of proposal; e.g., • prepare detailed project plan that includes purpose, deliverables, timelines, terms and resources • identify health and safety standards • define assessment standards (indicators of success) • obtain approval.	Has not yet provided evidence.
Complete project and/or performance as outlined*	Demonstrate passion and dedication to complete project, as outlined. Skillfully demonstrate the ability to apply and model leadership skills to solve problems, make decisions and complete tasks as planned.	Demonstrate initiative to complete project, as outlined. Competently demonstrate the ability to apply leadership skills to solve problems, make decisions and complete tasks as planned.	Demonstrate a willingness to complete project, as outlined. Satisfactorily demonstrate the ability to apply skills to solve problems, make decisions and complete tasks as planned.	Work, with constant supervision, toward completion of the project, as outlined. Often need help to demonstrate the ability to apply skills to solve problems, make decisions and complete tasks as planned.	Has not yet provided evidence.

Criteria	Excellent	Proficient	Adequate	Limited	Insufficient
Comply with safety standards and monitor performance during project*	Transfer and apply health and safety standards to all working environments throughout the project. Effectively monitor progress and make significant adjustments for improvement. Ask insightful questions when necessary. Consistently adhere to planned deadlines.	Apply health and safety standards to all working environments throughout the project. Somewhat effectively monitor progress and make appropriate adjustments for improvement. Ask relevant questions when necessary. Usually adhere to planned deadlines.	Apply, with assistance, health and safety standards to all working environments throughout the project. Follow the lead of others to monitor progress and make adjustments for improvement. Ask reasonable questions when necessary. Sometimes adhere to planned deadlines.	Apply, with constant supervision, health and safety standards to all working environments throughout the project. Need the support of the teacher to monitor progress and make adjustments for improvement. Need to ask questions when necessary. Rarely adhere to planned deadlines.	Has not yet provided evidence.

Criteria	Excellent	Proficient	Adequate	Limited	Insufficient
Present project and/or performance	Share a wide variety of personal experiences related to achieved outcomes and their relationship to the field study and original goals of proposed project.	Share some personal experiences related to achieved outcomes and their relationship to the field study and original goals of proposed project.	Share a personal experience related to an achieved outcome and its relationship to the field study and original goals of proposed project.	Need help to share a personal experience related to an achieved outcome and its relationship to the field study and original goals of proposed project.	Has not yet provided evidence.
Evaluate project and/or performance*	Use rubrics, exemplars and feedback effectively to examine processes and strategies throughout project planning and implementation. Make significant recommendations for improvement upon completion of project.	Use rubrics, exemplars and feedback somewhat effectively to examine processes and strategies throughout project planning and implementation. Make relevant recommendations for improvement upon completion of project.	Use rubrics, exemplars and feedback adequately to examine processes and strategies throughout project planning and implementation. Make predictable recommendations for improvement upon completion of project.	Need help to use rubrics, exemplars and feedback to examine processes and strategies throughout project planning and implementation. Use the ideas of others to make recommendations for improvement upon completion of project.	Has not yet provided evidence of this performance outcome.
Complete career outcome as identified in course*	Give an insightful explanation of connections between your	Give a relevant explanation of connections between your field study, your	Give a reasonable explanation of connections between your	Need others to explain connections between your field study, your	Has not yet provided evidence.

Criteria	Excellent	Proficient	Adequate	Limited	Insufficient
	field study, your project and potential career pathways and or personal values and goals. Give insightful explanation of the impact of this process on potential career pathway plan.	project and potential career pathways and or personal values and goals. Give relevant explanation of the impact of this process on potential career pathway plan.	field study, your project and potential career pathways and or personal values and goals. Give reasonable explanation of the impact of this process on potential career pathway plan.	project and potential career pathways and or personal values and goals. Need others to explain the impact of this process on potential career pathway plan. .	
Comments:					

*****To add more detail, share examples of how this criterion was met on the back or on a separate sheet.

SCIENCE 14

ACTIVITY SHEETS

Lesson #2 Lab Stations: Student Copy

Station 1:

Question: Is it possible to design a working model of the hydrologic cycle by collecting condensation from saltwater?

Materials:

- a hot plate
- 500 ml Beaker
- Tin foil
- salt
- ice cubes
- Large "waste" container

Safety:

- Never turn your back to a heating beaker
- Keep safety goggles on at all times
- Boiling water can burn skin instantly
- Do not move the hot plate until it has fully cooled.

Procedure:

1. Fill the beaker with 200ml of water
2. Add ____ grams of salt to the beaker
3. Place the beaker on the centre of the hotplate and turn it on the high setting
4. Carefully cover the top of the beaker with a piece of tinfoil
5. Place 2-3 ice cubes on the tinfoil, be careful not to let the ice cubes fall into the beaker
6. As the water in the beaker warms, make some observations
7. Once complete, turn off the hotplate, and notify your teacher to pour the water into the waste container

Observations: Make jot notes about what you see. Draw a sketch.

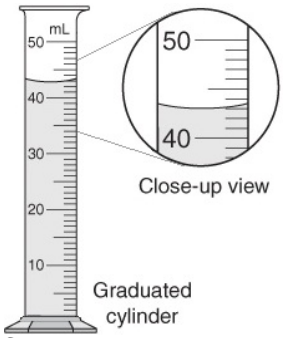
Discussion:

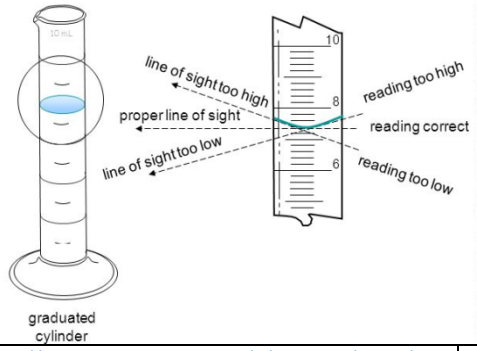
- What happened to the ice cubes?
- What happened to the air between the water and the tinfoil?
- What happened to the tinfoil?
- What happened to the salt?

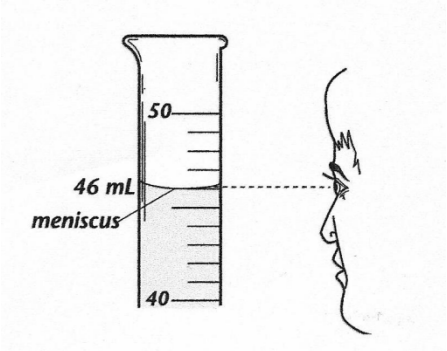
Conclusion: Answer the original question on the top of the page.

Station 2 has three mini stations that must be visited.

a. Can you correctly measure the amount of water in a graduated cylinder?
- Here is How:
  - Make sure the graduated cylinder is flat on the counter
  - Look closely, at eyelevel. There is a U shape that is called a Meniscus.
  - Always measure the amount of water, or other substance, from the bottom of the U shape.







Sources:

http://hinkhousescience.weebly.com/uploads/1/5/7/4/15746562/_9109887_orig.jpg	http://images.slideplayer.com/9/2564965/slides/slide_6.jpg	http://3.bp.blogspot.com/_ZdYuJRe-j_4/TOiFUSlzOSI/AAAAAAAAAAw/e52Hqaq8iaQ/s1600/miniscus1.JPG

- Look at the images of the graduated cylinders on the sheet.
  - How much water do you think is in each of the graduated cylinder images?

_____ _____ _____

- Measure the water in the three graduated cylinders set out for you:

_____ _____ _____

b. Measure the mass of an egg in different substances.

Safety: The eggs have had their shell removed, handle with care.

Directions:
1. Record the original mass of the egg and the type of liquid.
2. Carefully collect the egg out of the beaker, and take it to the scale.
3. Turn on the scale, and zero your scale by pressing the Tare button
4. Record the new mass of the egg in the table below.
5. Carefully return the egg to the beaker
6. Wash your hands.

Complete the following table:

	Substance 1_____	Substance 2_____	Substance 3_____
Mass before			
Mass after			
Same, gained or lost?			

- In which substances did the mass of the egg change? Why?

- Pick one substance and give a likely reason why the mass of the egg changed.

- Predict another substance you think that the same reaction may happen.

c. Question: Is salt water more or less dense than freshwater?

Hypothesis: If _____,

then_____.

Procedure:

1. Place an egg in freshwater, and observe what happens.
2. Rise off the egg with distilled water to avoid contamination.
3. Place an egg in saltwater, and observe what happens.

Conclusion: Was your hypothesis correct? Explain.

Discussion:

How could you float the egg in the middle of the beaker (not floating at the top or resting on the bottom)?

Station 3:
Problem: To determine how much sugar (solute) can be dissolved in cold vs warm vs room temperature water (solvent).

Safety:

- Never turn your back to a hot plate.
- Be careful around heated water, as a burn is instant.
- The sugar used is from a chemistry lab, so may have contamination from toxic materials (Do not put lab samples near face).
- Do not let the thermometer rest on the bottom of a heating surface, as it may break.

Variables: What other items need to be controlled, or stay the same? (i.e. amount of water, time, etc.).

Materials:

- ring clamp
- hot plate
- Thermometer
- Timer (phone)
- Sugar
- 3 small beakers of the same size
- Cold tap water
- Room temperature water set out the night before
- Ice cubes
- Stirring rod

Procedure:

1. Fill each beaker with _____ ml of water.
2. Place one beaker on the center of the hotplate and turn it on to the high setting
3. Place 3 ice cubes into the beaker with the cold tap water
4. Carefully measure the temperature of the room temperature water and record your results
5. Start the timer, and slowly add a tablespoon of sugar and stir until dissolved. Stop the timer and record your results.
6. Add as many tablespoons as needed until the sugar does not dissolve anymore. Record the time it took and the number of tablespoons of sugar that were completely dissolved.
7. With the cold-water beaker, follow steps 4, 5 and 6
8. Turn off the hot plate.
9. With the hot water beaker, follow steps 4, 5, and 6. Caution: do not allow the thermometer to touch the bottom of the beaker.

Observations:

	Cold water	Room temperature water	Hot water
Volume of water used			
Water temperature			
# of table spoons of sugar (solute)			
Time for sugar to dissolve			

- Which beaker of water dissolved the most sugar? The least sugar?

- Which beaker of water dissolved the sugar quickly? Which took the longest amount of time?

Discussion:

- Can more solute be dissolved in warm water? Why?

- What do you predict will happen when water cools?

- What do you think happens to solutes in water from summer to winter?

- If you were to do this lab again, what would you do differently?

Station 4:

Question: How long does it take to boil room temperature tap water? Salt water? Contaminated water?

Materials:

- 3 beakers of the same size
- Measure _____ml of water of room temperature tap water, salt water, and contaminated water
- Measure the temperature of each and record your results
- Remove the thermometers from the beakers
- Place beakers on the hotplates and as soon as the heat is set to high, turn on the timer (do all 3 at the same time).
- As soon as the water starts to boil, record the time and take the temperature of the water. *Caution: Do NOT place the thermometer on the bottom of the beaker. Remove the thermometer as soon as the temperature is recorded*

	Tap water	Salt water	Contaminated water
Length of time to boil			
Temperature when boiling			

Conclusion: Answer the question at the start of this lab.

Discussion: Was there a difference as to which type of water boiled faster? Which one? Why?

Predict what may happen if pollution was added to an ecosystem? How would this impact the living things?

Predict what may happen when these same substances freeze.

Station 5:

Question: How does water respond to different temperatures?

Materials:

- Large glass pan (~15" L x 10" W x 2" H)
- 2x Clamp stand base (remove rod)
- Tea candle
- Ice cubes
- Food colouring

Procedure:

1. Place the clamp stand bases far enough apart to hold the glass pan.
2. Make sure there is enough space under the pan to slide a tea candle under the pan on one side, and an ice cube under the other side.
3. Fill the pan (halfway) with tap water.
4. Carefully light the candle *Caution*
5. Drop one drops of food colouring into the pan and watch what happens. Repeat one drop in 3-4 other locations in the pan. Sketch what you see.
6. Very carefully tip the water into a sink *caution*

Sketch:

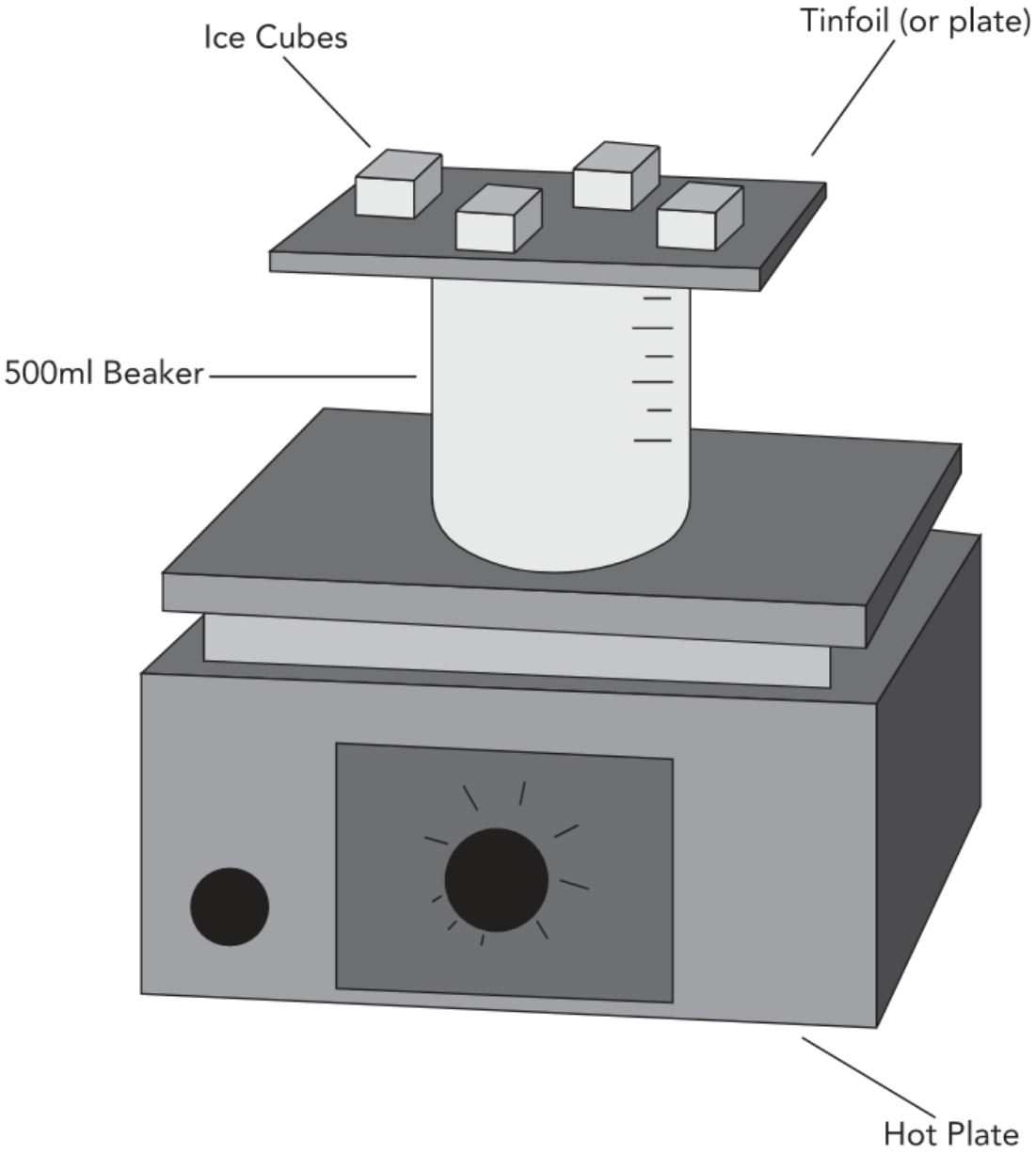
Conclusion (answer the question at the start of the lab):

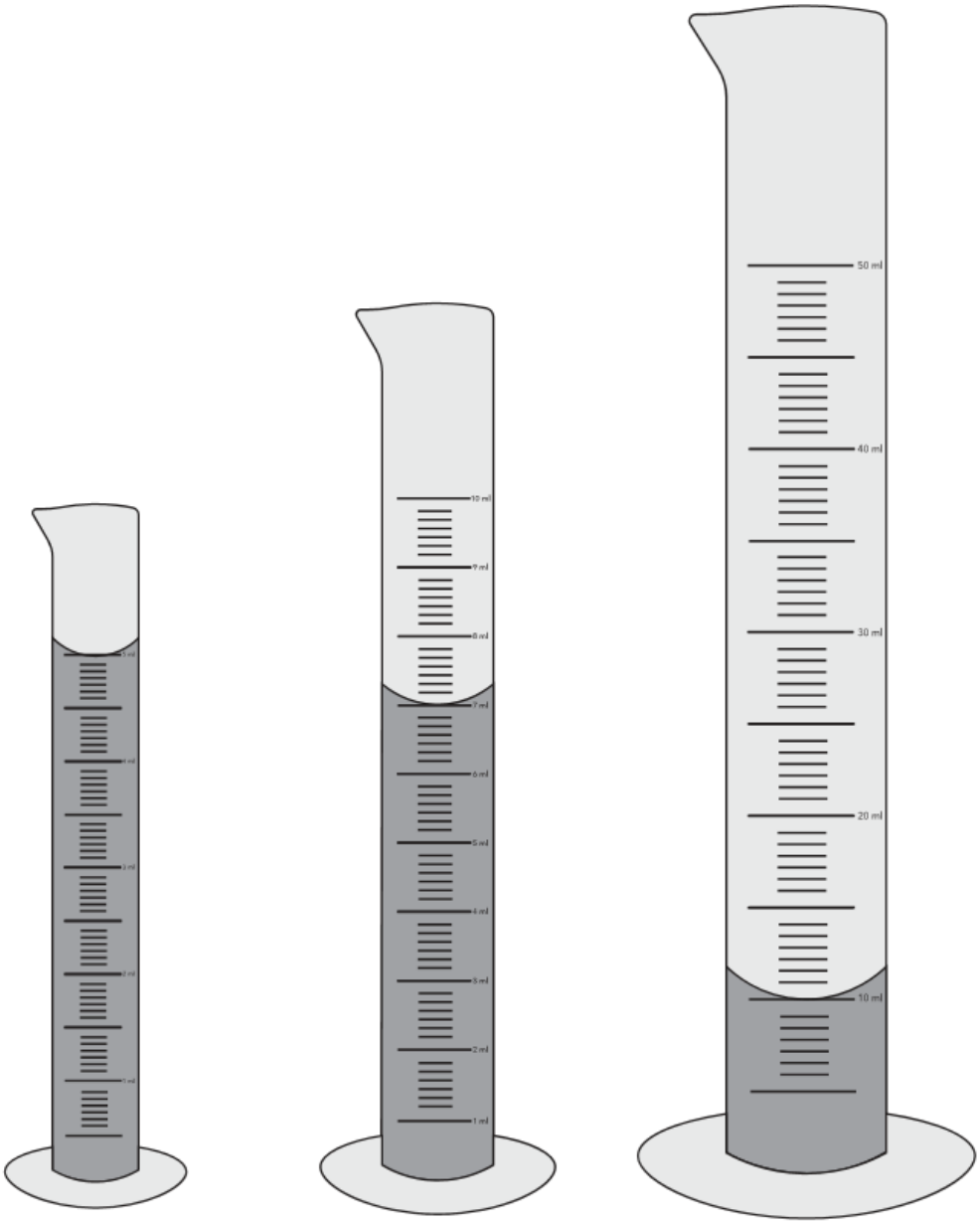
Discussion:

- Where does the warm and cool water mix?

- Predict what would happen if the cool water warmed.

LAB DIAGRAMS:

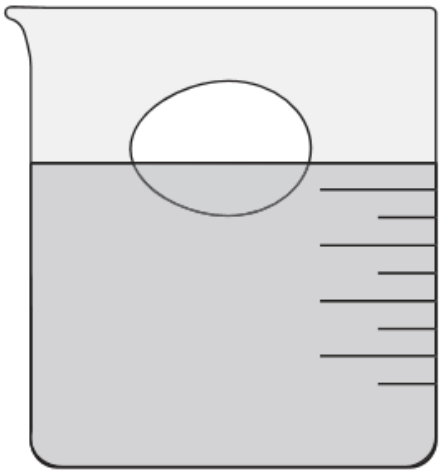




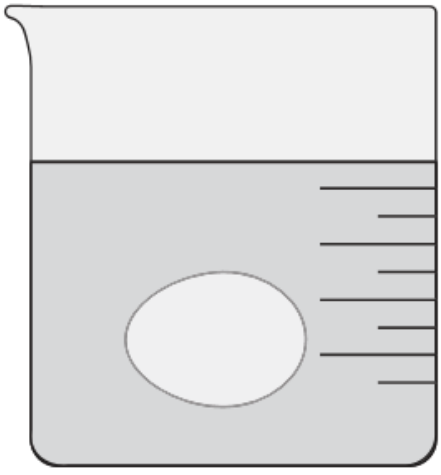
5ml Graduated Cylinder

10ml Graduated Cylinder

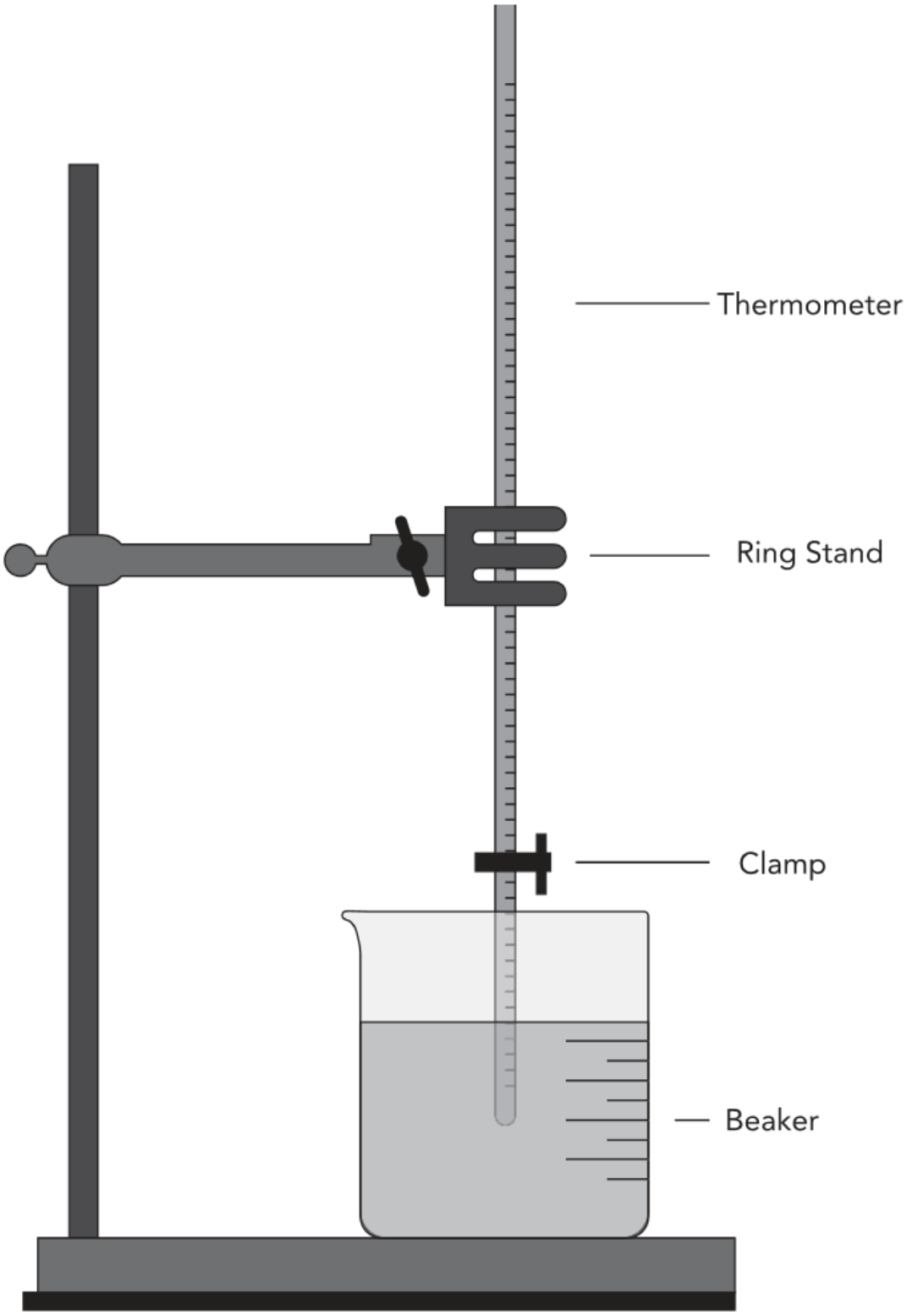
50ml Graduated Cylinder

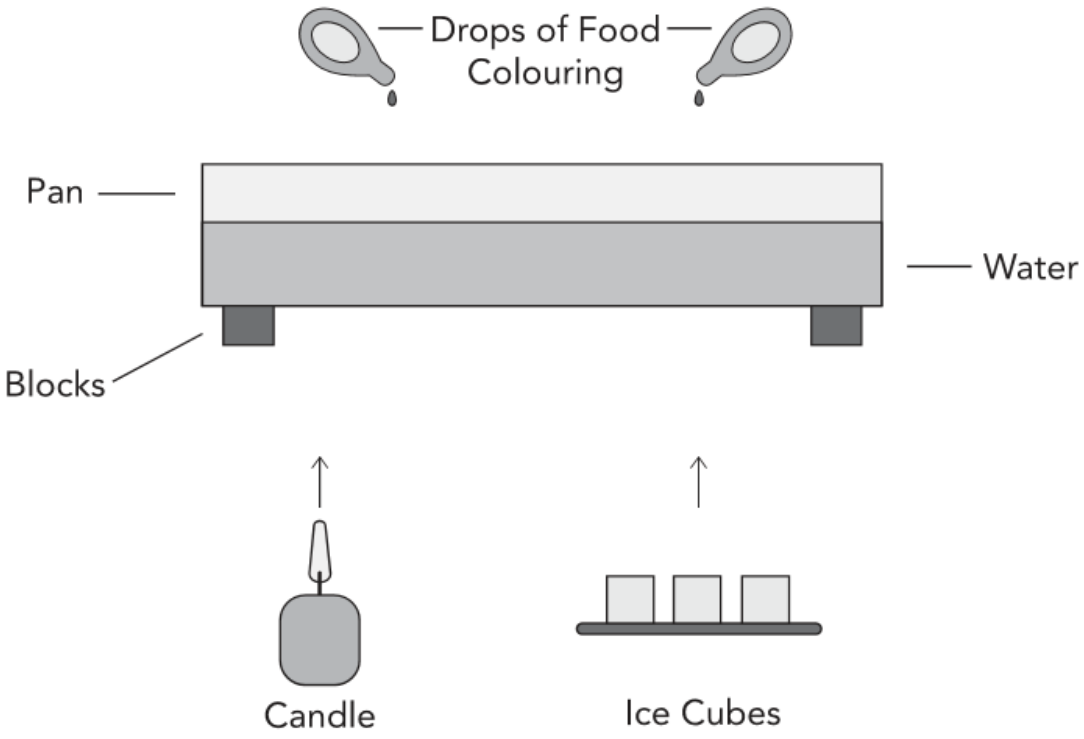


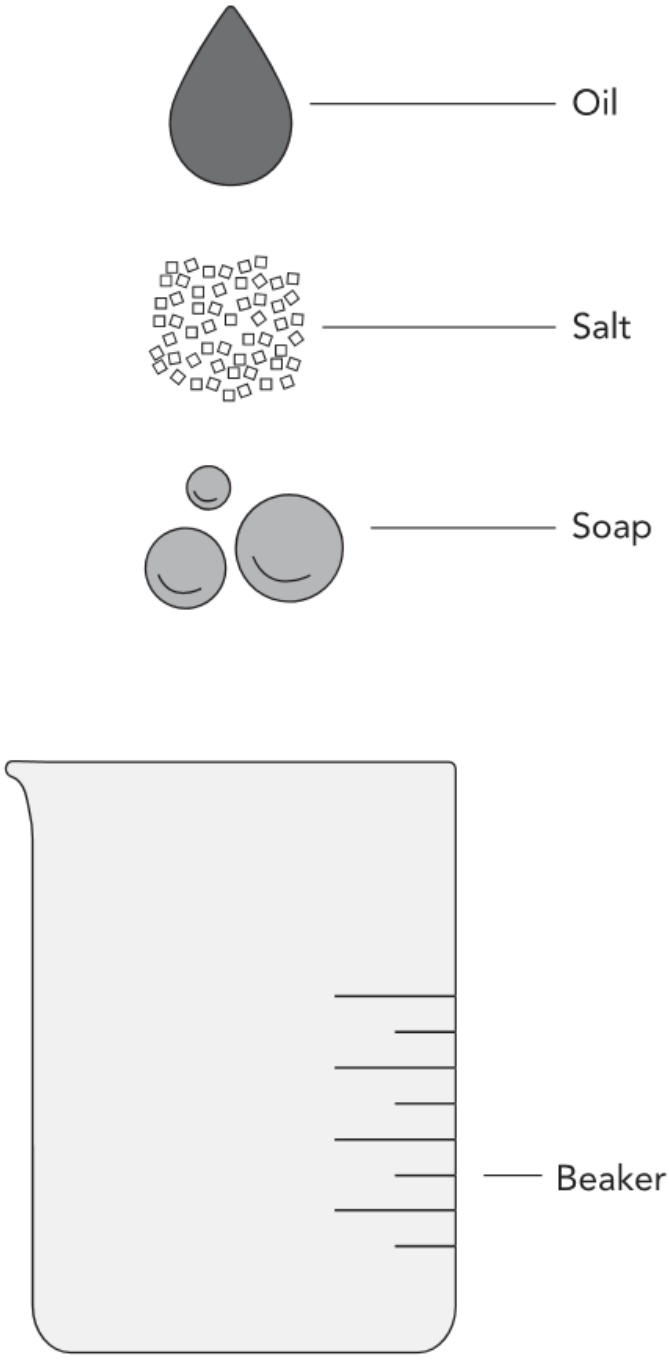
Salt Water



Fresh Water


Thermometer
Ring Stand
Clamp
Beaker


Drops of Food Colouring
Pan
Water
Blocks
Candle
Ice Cubes


Oil
Salt
Soap
Beaker

Lesson #3 Computer Activity: Aquatic Food Chains & Food Webs

1. The Food Chain.

   Click on the following link:

   http://www.sheppardsoftware.com/content/animals/kidscorner/foodchain/foodchain.htm

   Fill in the following blanks based on the four short paragraphs found on this page.

   a. Every living thing needs _____ to live.

   b. All living things get energy from _____.

   c. A _____ shows how each living thing gets food, and how _____ and _____ are passed from creature to creature.

   d. Food chains begin with _____-life, and end with _____-life.

   e. Observation from the picture: Which way does the arrow always point? Why?

2. The Bigger Food Chain.

   Click on the following link:

   http://www.sheppardsoftware.com/content/animals/kidscorner/foodchain/foodchain2.htm

   Fill in the following blanks based on this page.

   a. At each link in the chain, energy is being _____ from one _____ to another.

   b. Food chains make a full _____, and energy is passed from _____ to _____ to _____ and back to _____.

   c. Does 100% of the energy go from one organism to the next? Why not? Give some examples of what else uses energy to survive.

3. Food Chain Game.

   Click on the following link to play the game:

   http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm

   Drag and drop the different life forms into the correct boxes. Remember why the arrows point a certain way. There are 7 different chains to complete, getting more complex each time.

   Complete the following questions:

   a. What life form converts the energy from the sun?
   b. If a dolphin needs to eat many times a day to get the energy it needs, what do you think might happen to dolphins if some of the food a dolphin eats, gets contaminated?
   c. What do you think would happen to an eagle, if the food it eats is no longer available to eat? Would the number of eagles go up? Down? Stay the same? Explain.
   d. What do you think would happen to the mice if the snakes are no longer there? Would the number of mice go up? Down? Stay the same? Explain.
   e. The arrows always point the direction that the _____ goes.
   f. Several food chains that interact form a food _____.

4. Build a Food Web

   Click on the following link:

   http://teacher.scholastic.com/activities/explorer/ecosystems/be_an_explorer/map/line_experiment14.swf

   Read the directions and click start. You will know you have completed the web correctly when "Great Job" pops up.

   a. What might happen to a food web if there is a fire, or a flood?

b. For food chains, and food webs to work, do you need more plants? Or more meat eaters? Explain.

5. Food Web Game

Click on the following link:

http://coolclassroom.org/cool_windows/home.html

Click on “skip login” and follow the instructions

Click on the organism to find out what it is and look for hints, then drag and drop it to where you think it belongs in the food web. Watch the bottom white box to get feedback. Are you getting them on the right level?

a. Regarding a food web, why is it important to eat a variety of food?

b. Both mussels and clams “filter” their food. What are they filtering? How is this beneficial to the rest of the organisms in the food web?

c. What is detritus?

Lesson #4 Jigsaw Activity:

What is industry doing to improve water recovery and water quality?

Introduction: All industry in Alberta requires the use of water. As citizens, it is important to know the answers to the following questions: How is it used? Where does it go? How is it cleaned? And how is it returned? Who is making sure they are doing what they are supposed to be doing (monitoring them)? What is often upstream (where does the water come from) and downstream (where does the water go to)? Hand out the worksheet before dividing students into groups.

Step 1: Give each student a number from 1 to 6. Have all students with the same number gather in different locations around the classroom to work together. Each number will correspond with the industry their group is responsible for. Emphasize that ALL group members must have their work complete by the end of the time slot, as they will be that industry expert when they regroup with other students later.

1. Oilsands
2. SAGD
3. Farming (grain & cattle)
4. Forestry
5. City/town use
6. Tourism

All group members must have their sheet completed before moving to the next group. Remind students that they will now become the only expert in their group!

Step 2: In each expert group, give each student one of the following colours: red, orange, yellow, green, blue, purple. Have all students in that colour gather together in various locations around the classroom. There should be one expert from each industry in each group.

Expert Group #____ Industry Assigned to Study: _____

	Answer	**Source:** name, date, URL
Where in the province of Alberta, is your industry located?		
What product does your industry produce?		
What is water used for?		
How much water is used each day/year, etc.		
Where does the water come from?		
Does it all get returned? How much?		
What happens to the water that is not returned? (matter cycles)		
How is the water cleaned before it is returned?		
Who is monitors this industry?		
What is often upstream (where does the water come from, and who is there)?		
What is downstream (where does the water go to)?		

As a group answer the following questions:

- What surprised you about this industry?
- What do you think needs to be improved with your industry? How?
- As a citizen, are you satisfied with your findings? Explain.
- Does returning the water in a reasonable way hurt or help your industry? Why?

Share: Group Colour _____

	Oilsands	SAGD	Farming (grain & cattle)	Forestry	City/town use	Tourism
Where located?						
Products produced?						
Water used for?						
How much is used?						
Where does water come from?						
Is it all used?						
Who monitors?						
Upstream?						
Downstream?						

As a group discuss the following:

- Which industry is the best at cleaning their water? Explain.
- Which industry is the worst at cleaning their water? Explain.
- As an Alberta citizen, are you happy with how industry is using water? Explain.

Lesson #7 Example Biotic/Abiotic Factors Example Brainstorm List

Biotic Factors	Abiotic Factors
• Plants (trees, shrubs, grasses, moss, etc.)	• pH (soil, water)
• Animals (birds, insects/spiders, fish, mammals, etc.)	• Temperature (air, soil, water)
• Single celled organisms (protists)	• Flow rate
	• Wind speed
	• Cloud cover
	• Nitrogen/phosphorous/magnesium/ hardness (depends on available kits at your school)
	• Dissolved oxygen
	• Latitude, elevation, topography

Lesson #7 Example Data Sheet

Date: _____

Group members: _____

I. Abiotic Factors

Time of day (use 24-hour clock):	
Cloud cover (describe):	
Precipitation (describe and measure with units):	mm rain, **or** cm snow
% Humidity (measure or check local weather info):	%
Topography (describe):	
Elevation (measure or refer to local data; include units):	m
Latitude & longitude (use GPS or other reference data):	^{o}N, ^{o}W
Air Temperature (include units):	^{o}C
Wind Speed (include units):	km/hr
Visibility (describe):	
Soil Temperature (include units):	^{o}C
Soil pH:	
Water Temperature (include units):	^{o}C

Water pH:	
Water Flow Rate (include units):	m/s
Visibility/ Turbidity of Water (describe and/or measure):	
Dissolved oxygen in Water (measure & include units):	mg/L
Additional Water Quality Indicators: (mg/L) Nitrates Phosphorous Magnesium Hardness (measure & include units)	
Other:	

II. Biotic Factors

	Name or Description	Tally
Birds:		
Insects in the air:		
Mammals:		
Land insects/spiders/ worms, etc:		
Mammals:		
Trees:		
Shrubs:		

Grasses:		
Herbaceous (flowering)plants:		
Moss/lichen:		
Fish:		
Water Insects:		
Single celled water organisms (microscope):		
Other:		

NOTE: Electronic probes are available for testing water quality indicators such as those from Vernier (https://www.vernier.com/products/books/wqv/). The website also provides background information on each of the water quality indicators explaining why each factor is important.

Lesson #10 Energy Pyramid Activity (Teacher Resource)

Adapted from
http://www.cfep.uci.edu/cspi/docs/lessons_secondary/energy%20biomass%20pyramids.pdf

Objectives: Students will participate in an activity to role-play how energy if transferred from one organism to the next within an ecosystem

Materials:

- Role cards with organisms (30 players + the teacher)
  - 16 diatoms (primary producers)
  - 8 copepods (primary consumers)
  - 4 herring (secondary consumers)
  - 2 chum salmon (tertiary consumers)
  - 1 killer whale (the teacher!)
- Plastic or paper chips or markers, to represent "energy" (48 green)

Procedure:

a. Show and discuss the following oceanic food chain to the class:

Diatom→ Copepod →Herring →Salmon →Killer Whale

b. Place all of the role cards into a bag/hat, and ask students to randomly draw a card with an organism.

c. Students who draw the diatoms and copepods enter the play area first.
   - Each diatom is given 3 green energy circles.
   - At 'GO' the copepods attempt to "eat" the diatoms by tagging them.
   - When a diatom is tagged, it must give up one of its energy circles.

d. After 30 seconds, the herring enter the area.
   - When a herring tags a copepod, it receives two energy circles.

e. After another 30 seconds, the salmon enter the area.
   - They receive four circles when they tag a herring.

f. Finally, the killer whale enters.
   - It receives eight circles per salmon tag.

g. Once complete, have students record the number of energy circles accumulated by each level on a chart on the board (see results table below).

Results:

Organism	Energy Circles Accumulated
Diatom	
Copepod	
Herring	
Salmon	
Killer Whale	

Class Discussion Questions:

1. In looking at the results, what do you notice in where the green energy circles are?
2. Does energy transfer completely from one level to the next?
3. Place your organisms and number of green energy circles on the pyramid
4. Where should the Sun be added to the pyramid? (the source of all energy)
5. What are some possible explanations for why all of the energy does not transfer to the next level?
6. Why are there only a limited number of top predators (i.e. killer whales) in the ocean?
7. On the pyramid sketch, add trophic levels (primary, secondary, tertiary), consumers, and producers.
8. As a class, create a pyramid that would represent the local aquatic ecosystem where data was collected in the previous lessons. Discuss the cycling of matter and energy in the ecosystem.

Lesson #11 Compare and Contrast Analysis

Class Data

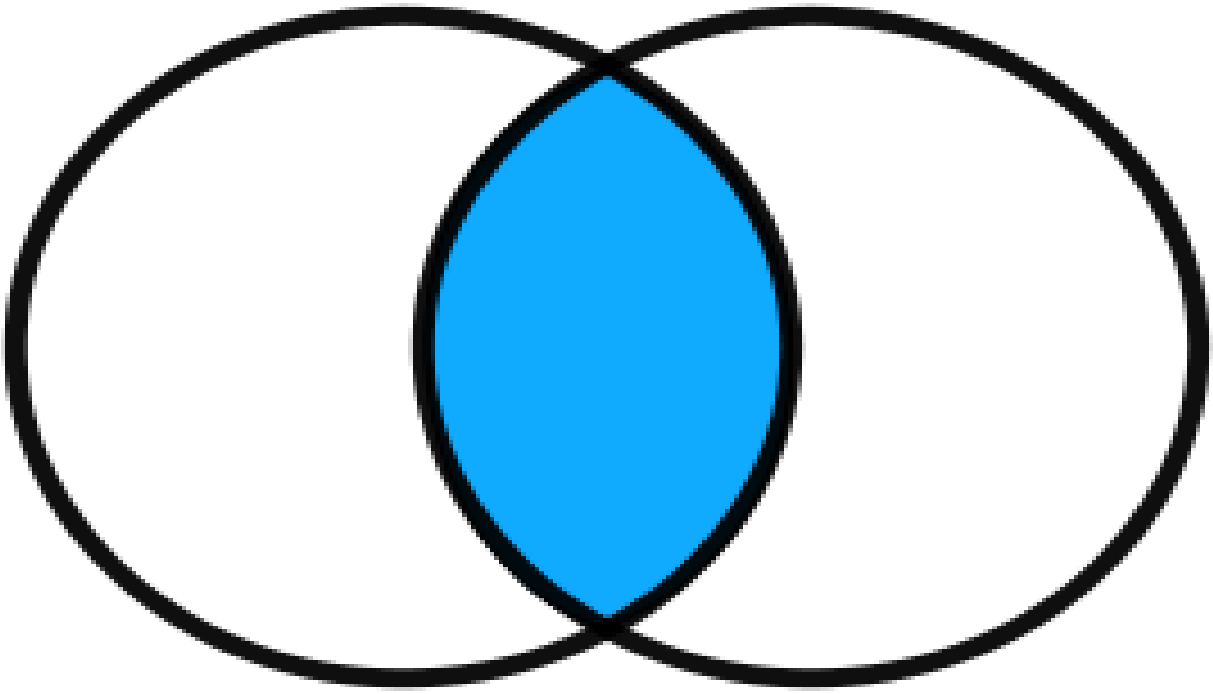
Location: _____

Biome: _____

Other Data

Location: _____

Biome: _____



Determine the following:

- What factors are the same? List them
- What factors are different? List them. By how much?
- In a group, discuss what factors may contribute to the differences.
- What industries or other human/animal activity are located upstream?
- Could abiotic factors such as latitude, topography, temperature, or precipitation contribute to the similarities and differences?
- Are there any factors that you think are a concern? Explain.
- Are you surprised by your findings? Explain.

Present your findings to the Class:

Suggested script:

- We compared our class data to the data from _____.
- This location is _____ km (north/south/east/west) of us.
- We live in the _____ biome, while the data we compared was from the _____ biome.
- Look at your compare and contrast sheet and state some of the differences
- State why you think they are different.

Lesson #11 Word Jumble

Causes an INCREASE in population (+)	Causes a DECREASE in population (-)

Sort the following words into the above table:

Immigration
Emigration
Birth rate
Death rate
Food supply
Predation
Disease
Reproductive rate
# of offspring produced
Climate change

Discussion:

1. Can any of these factors increase and decrease? Explain.
2. Students may place food supply and climate change on both. Food supply may be interrupted or improve. Climate change may increase agriculture in some northern locations, but decrease in areas close to the equator.

Lesson #12 Activity: Interactions Among Organisms (Teacher)

Adapted from:
http://ysp.wustl.edu/KitCurriculum/EcologicalInteractions/EcoEvo_Ecological%20Interactions%20Kit_TeacherHandout.pdf

NOTE: Students should be cautioned against eating the Smarties (never eat in the science lab/classroom). If Smarties are too tempting, consider using a non-edible alternative!

Teacher Instructions:

1. Put students in groups of 3. Each student is a different species (Species A, B and C).

2. Each group gets a bowl of Smarties and a set of cards. Each student gets a spoon, and cup.
   a. The set of cards can be printed back to back, and cut out. Have students draw a card for each round (indicated on the face up side).

3. For each game, have students pick a card, and carefully read the instructions on their card about how they can survive the winter. Students should keep their instructions hidden from other group members.

4. Place the bowl of Smarties in the center of each group. Students will use a spoon to collect Smarties and place them into their cups. No stealing from other student's cups unless your instructions tell you to do so.

5. Time each game for 1 minute (or less). At the end of the game, students should record how many Smarties each species collected, then return the Smarties to the bowl and answer questions.

6. Discuss as a class.

7. Time permitting: For an added challenge, hand out one spoon, one fork and one craft stick to each group rather than a spoon for each student and redo each game.

Lesson #12 Activity: Interactions Among Organisms (Students)

Student Instructions:

- Each person in your group represents a different species (Species A, Species B, and Species C), so each person gets a different card, with different instructions. Don't let anyone else see the instructions on your card, or they'll have a better chance of beating you!

- Put the bowl of Smarties in the center of your group, and give each group member a spoon. Use the spoon to collect Smarties—*only one at a time*. Leave your cup on the table, not in your hand. No cup guarding!

- At the end of the round, count how many Smarties you collected, fill out the table, and answer the related questions. Then, put all of your Smarties back into the community bowl for the next round.

Game 1

	Species A	**Species B**	**Species C**
Number of Smarties collected in the cup			
Did the species collect enough food to survive the winter?			

1. Which ecological relationship do:

   a. Species A and Species B have? (parasitism / competition / none)

   b. Species A and Species C have? (parasitism / competition / none)

   c. Species B and Species C have? (parasitism / competition / none)

2. Why will two species not be able to occupy the same location in a community for very long?

Game 2

	Species A	**Species B**	**Species C**
Number of Smarties collected in the cup			
Did the species collect enough food to survive the winter?			

1. Which ecological relationship do:

   a. Species A and Species B have? (parasitism / competition / none)

   b. Species A and Species C have? (parasitism / competition / none)

   c. Species B and Species C have? (parasitism / competition / none)

Game 3

	Species A	**Species B**	**Species C**
Number of Smarties collected in the cup			
Did the species collect enough food to survive the winter?			

1. Which ecological relationship do:

   a. Species A and Species B have? (parasitism / competition / none)

   b. Species A and Species C have? (parasitism / competition / none)

   c. Species B and Species C have? (parasitism / competition / none)

ii) What would happen if a new invasive species came into your ecosystem that ate blue, red, and orange Smarties and was better at collecting food than all three of your species?

3. “All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem.” Do you agree with this statement? Why or why not?

Lesson #12 Activity: Interaction Among Organisms Game Cards I

(one set per group) – double-sided with Game Cards II sheet

Game 1 - Species C What you need to do to survive: You can eat yellow Smarties. All other colours will make you sick. You must collect at least 6 yellow Smarties to survive the winter.	**Game 1 - Species B** What you need to do to survive: You can eat green Smarties. All other colours will make you sick. You must collect at least 6 green Smarties to survive the winter.	**Game 1 - Species A** What you need to do to survive: You can eat green Smarties. All other colours will make you sick. You must collect at least 6 green Smarties to survive the winter.
Game 2 - Species C What you need to do to survive: You can eat any colour of Smarties, but you can only eat those that Species A or B have already put into their cups (not the bowl). You need at least 6 Smarties to survive the winter.	**Game 2 - Species B** What you need to do to survive: You can eat purple and orange Smarties. You need at least 6 Smarties to survive the winter. If another species tries to take your Smarties, you cannot stop them, or guard your cup.	**Game 2 - Species A** What you need to do to survive: You can eat red and blue Smarties. You need at least 6 Smarties to survive the winter. If another species tries to take your Smarties, you cannot stop them, or guard your cup.
Game 3 - Species C What you need to do to survive: You can eat blue and green Smarties. Red Smarties are dangerous to your babies, so you should remove them from the bowl before collecting the ones you need. You must collect at least 6 Smarties to survive the winter.	**Game 3 - Species B** What you need to do to survive: You can eat blue and green Smarties. Red Smarties are dangerous to your babies, so you should remove them from the bowl before collecting the ones you need. You must collect at least 6 Smarties to survive the winter.	**Game 3 - Species A** What you need to do to survive: You can eat blue Smarties, but you can only eat those that Species B and C have put into their cups. You need at least 6 Smarties to survive the winter.

Lesson #12 Activity: Interactions Among Organisms Game Cards II

(double-sided with Game Cards I)

Game 1 - Species A **Face up**	**Game 1** - Species B **Face up**	**Game 1** - Species C **Face up**
Game 2 - Species A **Face up**	**Game 2** - Species B **Face up**	**Game 2** - Species C **Face up**
Game 3 - Species A **Face up**	**Game 3** - Species B **Face up**	**Game 3** - Species C **Face up**

CAREER AND TECHNOLOGY STUDIES

Wading in for Water Action Project

ACTIVITY SHEETS

Lesson #5 WebQuest Scavenger Hunt (Student Copy)

1. The Water Cycle

a) Go to the following diagram and complete the questions below: https://water.usgs.gov/edu/watercycle-kids-int.html

i) Define each of the following terms and explain why each of these is an important factor to consider for your action project

Runoff

Seepage

Infiltration

2. Point and Non-point Source Contamination

a) Go to the image at the following link: https://www.e-education.psu.edu/earth103/node/899

i) Describe what is happening in the image titled "Potential sources of contamination in drinking water" in a short paragraph

b) Go to the following website: http://www.aadnc-aandc.gc.ca/eng/1398369474357/1398369572276#chp2

i) Define and give five examples of point source contamination.

ii) Define and give five examples of non-point source contamination.

3. Agricultural Development

a) Use this link to find an example of how agriculture can contaminate water.

b) Go to the following page http://wwf.panda.org/what_we_do/footprint/agriculture/impacts/pollution/ and answer the next questions:

i) According to the World Wildlife Fund, what are two of the ways that farming can contribute to water pollution?

ii) What percentage of the world's planted crops does cotton represent?

iii)What percentage of the world's insecticide use does cotton account for?

iv) What percentage of the world's pesticide use does cotton account for?

4. Energy Projects

a) Watch this video by ConocoPhillips on their approach to water and answer the following:

i)According to ConocoPhillips, why are horizontal drilling and hydraulic fracturing better for the environment? (0:30)

ii) How are drill sites selected? (1:00)

iii) How are the aquifers protected from contamination through upward migration? (2:10)

iv) How long is the life of a hydraulic fracturing well compared to a conventional well? (3:24)

v) What happens to the waste water from drilling sites? (3:40)

b) Look at this diagram and explain how hydraulic fracking reduces the number of wells required to access natural gas in shale beds.

c) Using this article from the Canadian Press, name five concerns that the government of Newfoundland and Labrador believed needed to be addressed before shale gas sites can be approved.

5. Urban and Suburban Development

a) Read the short article here: http://oceanservice.noaa.gov/education/kits/pollution/05areas.html and answer the following:

i)Why is runoff in urban and suburban areas a problem for water quality?

ii) What problem do construction sites cause for water systems?

iii) What threat does lawn care in suburban environment pose for water systems?

Lesson #5 WebQuest Scavenger Hunt (Teacher Copy)

1. The Water Cycle

a) Go to the following diagram and complete the questions below: https://water.usgs.gov/edu/watercycle-kids-adv.html

i) Define each of the following terms and explain why each of these is an important factor to consider for your action project

Runoff: Water running over the land surface downhill due to gravity. This runoff reaches creeks, rivers, lakes and the ocean. Answers will vary for the explanation.

Seepage: Seepage occurs when precipitation falls on the landscape and starts to soak into the ground. Seepage does not just happen downward but happens upwards and sideways too, from the ground into the bottom of rivers, lakes and the oceans. Answers will vary for the explanation.

Infiltration: Water that soaks into the ground to recharge groundwater. Answers will vary for the explanation.

2. Point and Non-point Source Contamination

a) Go to the image at the following link: https://www.e-education.psu.edu/earth103/node/899

i) Describe what is happening in the image titled "Potential sources of contamination in drinking water" in a short paragraph

Answers will vary but the key points are that there are a number of different potential sources of contamination for groundwater. These sources include urban developments, industrial sites, agricultural operations, and waste facilities. Specific potential sources of contamination include leaking sewers, runoff and infiltration from landfills, agriculture, gas stations, the application of fertilizers and pesticides, road salt, manure, and waste water treatment. Industrial sites are potentially harmful as well due to the possibility of seepage and runoff affecting groundwater.

b) Go to the following website: http://www.aadnc-aandc.gc.ca/eng/1398369474357/1398369572276#chp2

i) Define and give five examples of point source contamination.

"Point Source Contamination": pollution that can be traced to a fixed point such as an effluent pipe, a smokestack, or a leaking fuel tank. Point source pollution enters the environment at a specific place from an identifiable source." Examples: industrial point discharges, as well as spills and leaks of industrial chemicals; municipal wastewater effluents; landfill site leachate; wastes from existing and abandoned mining sites; on-site septic systems; and leaking underground oil and gas storage tanks."

ii) Define and give five examples of non-point source contamination.

"Non-point source pollution. Non-point source pollution is pollution that cannot be traced to a fixed point such as recreation activity, roads, and urban runoff. Examples: urban runoff from buildings, streets and sidewalks that carry sediment, nutrients, bacteria, oil, metals, chemicals, pesticides, road salts, pet droppings and litter; bacterial and petroleum products from recreational boating; and acid precipitation and other forms of air pollution that fall into surface waters and onto the land."

3. Agricultural Development

c) Use this link to find an example of how agriculture can contaminate water.

"In agriculture, large tracts of land are typically plowed to grow crops. Plowing the land exposes and disturbs the soil, making it more vulnerable to erosion during rainstorms. This increases the runoff that carries fertilizers and pesticides away from the farm and into nearby waters."

b) Go to the following page http://wwf.panda.org/what_we_do/footprint/agriculture/impacts/pollution/ and answer the next questions:

i) According to the World Wildlife Fund, what are two of the ways that farming can contribute to water pollution?

Widespread Contamination through the increased use of pesticides, fertilizers, and other agrochemicals applied to fields and adjacent waterways; pesticides killing soil microorganisms, excess nutrients caused by the application of fertilizers

ii) What percentage of the world's planted crops does cotton represent?

2.4%

iii) What percentage of the world's insecticide use does cotton account for?

24%

a. What percentage of the world's pesticide use does cotton account for?
11%

4. Energy Projects

a) Watch this video by ConocoPhillips on their approach to water and answer the following:

i) According to ConocoPhillips, why are horizontal drilling and hydraulic fracturing better for the environment? (0:30)

More production with fewer wells reduces the environmental footprint of drilling operations relative to traditional drilling.

ii) How are drill sites selected? (1:00)

Well planning and geological studies are used to determine the best sites based on topography.

iii) How are the aquifers protected from contamination through upward migration? (2:10)

Well are located thousands of feet below groundwater. Multiple layers of impermeable rocks separate the wells from the groundwater, protecting the aquifers.

iv) How long is the life of a hydraulic fracturing well compared to a conventional well? (3:24)

2-3 months, compared to 20-30 years of typical well.

v) What happens to the waste water from drilling sites? (3:40)

Water is transferred to holding tanks and then transported to either safe disposal sites or reused in other company processes

b) Look at this diagram and explain how hydraulic fracking reduces the number of wells required to access natural gas in shale beds.

Answers will vary. Key points: it is possible to use the best spot topographically (ie the best soil, most insulated from contamination, safest for the operation and the community) to access the gas deposits from the surface and then drill horizontally to get at the gas from far below with one long concrete lined well. Conventional drilling would require multiple wells to access the same deposits and would require that these were accessed from directly above the deposits, on less geographically desirable land.

c) Using this article from the Canadian Press, name five concerns that the government of Newfoundland and Labrador believed needed to be addressed before shale gas sites can be approved.

Social licence, groundwater contamination, air pollution and increased earthquakes, sustainable tourism

5. Urban and Suburban Development

a) Read the short article here: http://oceanservice.noaa.gov/education/kits/pollution/05areas.html and answer the following:

ii) Why is runoff in urban and suburban areas a problem for water quality?

These areas are largely impervious, which makes it easier for stormwater to pick up, absorb and carry pollutants.

ii) What problem do construction sites cause for water systems?

Uncontained soil can erode and discarded materials can be carried away from the site by runoff waters

iii) What threat does lawn care in suburban environment pose for water systems?

The chemicals used in lawn care and pet wastes flow untreated into storm drains and then into nearby waterbodies.

Lesson #9: Personal Water Inventory

Track your water use for four days and record the number of times per day that you do each of the following tasks. You will need to determine what type of appliances you have and if you have any water saving devices in your home. Where you do not know this information, assume standard appliances and no water saving devices. Tally the number of uses per day and use this information to calculate your total water use per day. After four days, calculate your average water use per day.

Day One: _____

Type of Use	Efficiency of use (Circle the appropriate use)	# of uses per day	Amount of water per use	Calculation (# of uses per day x amount per use in L)	Total amount of water used per day
Toilet flush	Standard Toilet pre 1992: 13.2 litres per flush Ultra Low Flush (ULF): 6 litres per flush Dual Flush: ~4 litres per flush				
Shower	Standard Showerhead pre-1992: 13.2 lpm Showerhead post-1992: 9.5 lpm Low flow Showerhead: 5.7 lpm				
Tub Bath	Average Bath: 114 litres per bath				
Hand washing (lasts ~15 secs per wash)	Standard Hand Washing: 2.1 litres Low-flow Aerator: 0.48 litres				
Teeth brushing (with tap running)	Running Water for Two Minutes (Standard): 17 litres Running Water for Two Minutes (Low Flow Aerator): 3.8 litres Brush and Rinse: ~2.0 litres				
Outdoor watering	24 litres per minute from hose 0 litres per minute from rain barrel				
Dishwashing with dishwasher	Standard Dishwasher Pre-1994: ~47.2 litres per wash New Energy Star Dishwasher: 20.8 litres per wash				
Dishwashing by hand	Full sink wash and rinse: 11.4 litres Running water (5 minutes): 41.5 litres				
Washing machine	Conventional top-loader: ~161 litres Front loader: ~74 litres				
Total Water Use					

Day Two: _____

Type of Use	Efficiency of use (Circle the appropriate use)	# of uses per day	Amount of water per use	Calculation (# of uses per day x amount per use in L)	Total amount of water used per day
Toilet flush	Standard Toilet pre 1992: 13.2 litres per flush Ultra Low Flush (ULF): 6 litres per flush Dual Flush: ~4 litres per flush				
Shower	Standard Showerhead pre-1992: 13.2 lpm Showerhead post-1992: 9.5 lpm Low flow Showerhead: 5.7 lpm				
Tub Bath	Average Bath: 114 litres per bath				
Hand washing (lasts ~15 secs per wash)	Standard Hand Washing: 2.1 litres Low-flow Aerator: 0.48 litres				
Teeth brushing (with tap running)	Running Water for Two Minutes (Standard): 17 litres Running Water for Two Minutes (Low Flow Aerator): 3.8 litres Brush and Rinse: ~2.0 litres				
Outdoor watering	24 litres per minute from hose 0 litres per minute from rain barrel				
Dishwashing with dishwasher	Standard Dishwasher Pre-1994: ~47.2 litres per wash New Energy Star Dishwasher: 20.8 litres per wash				
Dishwashing by hand	Full sink wash and rinse: 11.4 litres Running water (5 minutes): 41.5 litres				
Washing machine	Conventional top-loader: ~161 litres Front loader: ~74 litres				
Total Water Use					

Day Three: _____

Type of Use	Efficiency of use (Circle the appropriate use)	# of uses per day	Amount of water per use	Calculation (# of uses per day x amount per use in L)	Total amount of water used per day
Toilet flush	Standard Toilet pre 1992: 13.2 litres per flush Ultra Low Flush (ULF): 6 litres per flush Dual Flush: ~4 litres per flush				
Shower	Standard Showerhead pre-1992: 13.2 lpm Showerhead post-1992: 9.5 lpm Low flow Showerhead: 5.7 lpm				
Tub Bath	Average Bath: 114 litres per bath				
Hand washing (lasts ~15 secs per wash)	Standard Hand Washing: 2.1 litres Low-flow Aerator: 0.48 litres				
Teeth brushing (with tap running)	Running Water for Two Minutes (Standard): 17 litres Running Water for Two Minutes (Low Flow Aerator): 3.8 litres Brush and Rinse: ~2.0 litres				
Outdoor watering	24 litres per minute from hose 0 litres per minute from rain barrel				
Dishwashing with dishwasher	Standard Dishwasher Pre-1994: ~47.2 litres per wash New Energy Star Dishwasher: 20.8 litres per wash				
Dishwashing by hand	Full sink wash and rinse: 11.4 litres Running water (5 minutes): 41.5 litres				
Washing machine	Conventional top-loader: ~161 litres Front loader: ~74 litres				
Total Water Use					

Day Four: _____

Type of Use	Efficiency of use (Circle the appropriate use)	# of uses per day	Amount of water per use	Calculation (# of uses per day x amount per use in L)	Total amount of water used per day
Toilet flush	Standard Toilet pre 1992: 13.2 litres per flush Ultra Low Flush (ULF): 6 litres per flush Dual Flush: ~4 litres per flush				
Shower	Standard Showerhead pre-1992: 13.2 lpm Showerhead post-1992: 9.5 lpm Low flow Showerhead: 5.7 lpm				
Tub Bath	Average Bath: 114 litres per bath				
Hand washing (lasts ~15 secs per wash)	Standard Hand Washing: 2.1 litres Low-flow Aerator: 0.48 litres				
Teeth brushing (with tap running)	Running Water for Two Minutes (Standard): 17 litres Running Water for Two Minutes (Low Flow Aerator): 3.8 litres Brush and Rinse: ~2.0 litres				
Outdoor watering	24 litres per minute from hose 0 litres per minute from rain barrel				
Dishwashing with dishwasher	Standard Dishwasher Pre-1994: ~47.2 litres per wash New Energy Star Dishwasher: 20.8 litres per wash				
Dishwashing by hand	Full sink wash and rinse: 11.4 litres Running water (5 minutes): 41.5 litres				
Washing machine	Conventional top-loader: ~161 litres Front loader: ~74 litres				
Total Water Use					

Daily Average Water Use:

Fill in your water use for each day below and find the average by adding up the value for each day and then dividing by four

Day One	Day Two	Day Three	Day Four	Total