Junior High
Teacher's Guide

BOW RIVER BASIN
WATERSCAPE POSTER

www.calgary.ca/waterworks call 3-1-1

THE CITY OF CALGARY

Acknowledgements

The activities in this guide were designed to complement the Bow River Basin Waterscape Poster, part of a series of posters developed by the Geological Survey of Canada (part of Natural Resources Canada) in partnership with many different agencies. To learn more about this poster series please visit www.geoscape.nrcan.gc.ca.

The Bow River Basin Waterscape was developed by the Geological Survey of Canada in partnership with the following agencies: the Bow River Basin Council, Alberta Environment, Climate Change Central, Calgary Roman Catholic School District No. 1, the Calgary Board of Education and the City of Calgary with participation of individuals from Parks Canada, the University of Calgary, Telus World of Science, the Prairie Farm Rehabilitation Administration and the SEEDS Foundation.

To ensure the poster is accessible as an educational resource, The City of Calgary worked with a group of elementary and junior high teachers from Calgary schools to create these interactive water activities to accompany the poster. The City of Calgary gratefully acknowledges the following individuals for creating, testing and editing these activities:

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Bow River Basin Waterscape

Introduction

We live in the basin of the Bow River, a remarkable tract of land that extends from the Rocky Mountains, across foothills and the rapidly growing City of Calgary, to the broad prairie. This land has been home to First Nations people for thousands of years. Within this basin, all waters flow into the Bow River. We share this water with plants and animals. Without this water, nothing could live. With this water, a great diversity of life, including humans, can thrive. As residents of the Bow River basin, we must protect the land that produces these life-giving waters. There are many challenges. Our rapidly growing population demands much of the land and water. Our climate is changing and the future of our water supplies is uncertain. To act wisely, we need first to understand our basin. The purpose of this poster is to introduce us to the local water cycle, how humans use the basin waters, and how we can live well on the land.

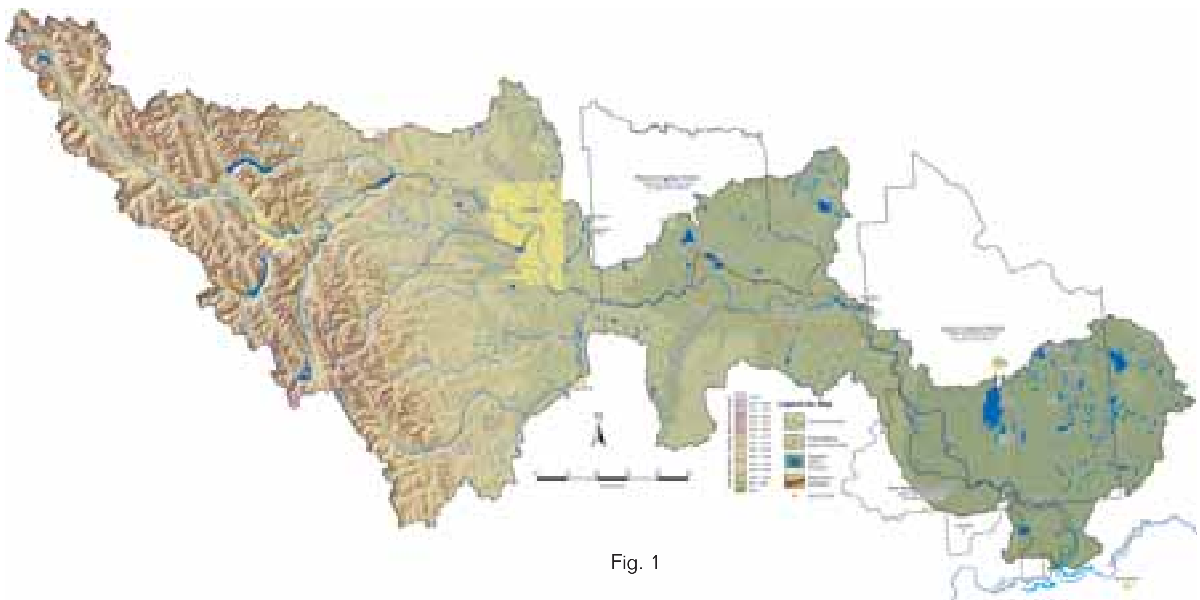


Fig. 1

Fig. 2

The Bow, Red Deer, and Oldman rivers are tributaries of the South Saskatchewan River. This family of rivers carries water from the Rocky Mountains across the dry southern prairies of Alberta and Saskatchewan.
The Bow River joins the Oldman River near Medicine Hat to form the South Saskatchewan River. Bow River waters flow all the way to Hudson Bay. Downstream communities that use these waters such as Medicine Hat and Saskatoon depend on us to care for the quality of the water as it passes through the Bow River basin.

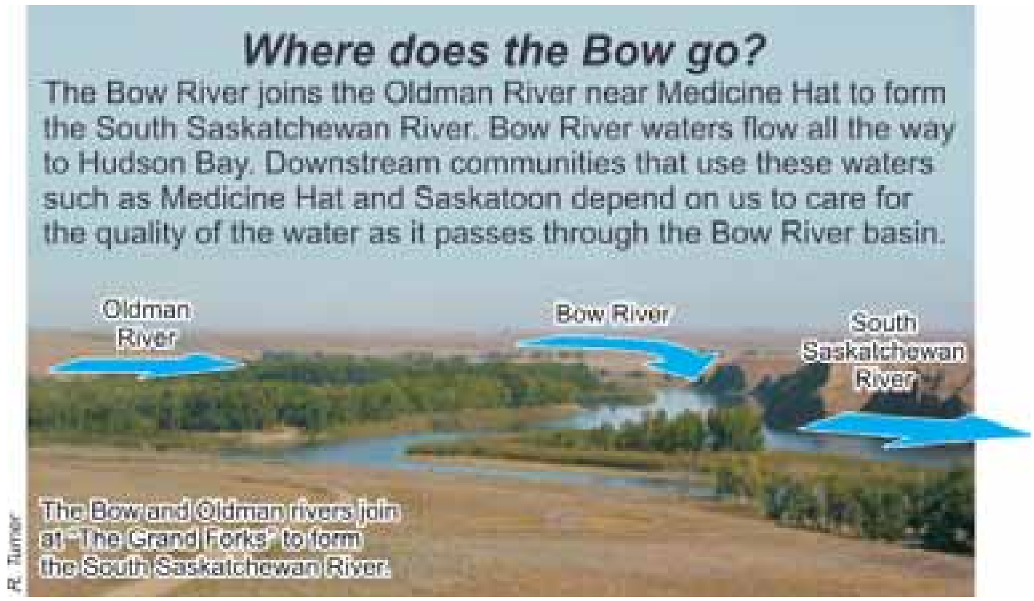


Fig. 3

Fig. 4

The Message

The underlying message throughout the poster is the importance of protecting and conserving the shared waters of our Bow River, ensuring a sustainable resource for future generations all along the watershed.

Activities

This guidebook consists of a collection of lessons and activities that support the various panels on the Waterscape poster. Each one is directly linked to the Alberta Learning Program of Studies and each is planned to relate to the student's local environment. Activities are designed to provide accessible, hands-on classroom experiences that will ensure our students gain the knowledge and deep understanding necessary to make well-informed decisions concerning water use, as well as an appreciation for steps that are being taken to conserve and protect this precious resource.

Graphics

Graphic files can be accessed online at www.geoscape.nrcan.gc.ca and www.brbc.ab.ca. Teachers are encouraged to find creative ways of integrating these visual aids into their lesson plans.

Fig. 5

Using Bow River Basin Waterscape in the Classroom

Investigating Topics Through Activities

Each panel on Waterscape focuses on a different topic relating to the Bow River basin. For each panel, there are specific activities that can be used to motivate students to investigate further, ask questions and strengthen connections between new and previously established knowledge. Activities include background information, curriculum objectives, learner prompts, materials, procedures and extensions. Each activity has undergone extensive scrutiny by experienced classroom teachers to ensure that they are actually do-able and that they provide the maximum learning potential for students in the classroom. Because of the closely-tied curriculum objectives, the activities in this guidebook are designed to be used with the Grade 8 Science Freshwater and Saltwater Systems and Grade 9 Environmental Chemistry units. However, they are not designed to cover all of the learner objectives in these units of study. There are other potential links to Grade 7–9 curriculum, including Grade 7 Science Interactions and Ecosystems and Planet Earth, as well as Grade 7–9 Social Studies (references tied to new curriculum). Math and Language Arts curriculum links are noted throughout the activities.

Inquiry Learning

Although each of the activities in this guidebook can stand on its own as either a classroom demonstration or a student-centred learning experience, the Waterscape poster provides an ideal tool to encourage a more comprehensive understanding of Alberta's water picture through longer term studies focusing on problems with multiple perspectives and multiple solutions. It is strongly recommended that teachers use Waterscape to lead students through an inquiry investigation where they will gain the necessary knowledge, build deeper meaning and recognize vital interrelationships between all of the "players'" involved in the Bow River watershed. Focus on Inquiry (Alberta Learning, 2004) provides an excellent reference for inquiry investigation and it can be accessed at http://www.education.gov.ab.ca/K_12/curriculum/bysubject/focusoninquiry.pdf. Included in this guidebook are two possible inquiry investigations, one for Grade 8 Science Topic E (Freshwater and Saltwater Systems) and one for Grade 9 Science Topic C (Environmental Chemistry). Both of these investigations are directly linked to the Social Studies curriculum and it is recommended that they be taught as interdisciplinary projects.

Prompts

Many of the activities in this guidebook start out with a prompt. These are short, attention-grabbing demonstrations or discussion topics that will help students focus in and get excited about what is going to happen before the lesson starts.

Extensions

The extensions at the end of activities can be used to allow classes to probe more deeply into topics that they find particularly interesting. They can also be used to differentiate curriculum for highly able students who prefer self-directed exploration of more complex tasks.

Curriculum Connections and Opportunities for Interdisiplinaria Using Waterscape Activities

ACTIVITY	SCIENCE	SOCIAL STUDIES	MATH	LA	FINE ARTS	TECH
Getting to Know the Bow	✔	✔		✔	✔	
The Grass Won't Always be Greener – G. 8 Inquiry Project	✔	✔	✔	✔	✔	✔
The Mystery of Dirty Bow H_2O – G. 9 Inquiry Project	✔	✔	✔	✔	✔	✔
Haute Contour	✔	✔				
Watershed Sculpture	✔	✔				
Water Cycle Model In a Bottle	✔			✔	✔	
Go With the Flow	✔	✔				
Please Don't Pass the Salt	✔	✔	✔			✔
Where Have All the Flow-ers Gone?	✔	✔	✔	✔		
Watershed Down	✔	✔				
Tasty Waste	✔	✔		✔		
What Goes In Must Come Out	✔	✔	✔			✔
Take a Bow, Calgary!	✔	✔	✔	✔		✔
Water Use Challenge	✔	✔	✔			
Irritating Irrigating	✔	✔		✔		✔
Flames Flushers	✔	✔		✔		✔
All Bogged Down	✔	✔		✔		✔
Bow River Reflections	✔	✔		✔	✔	

Specific curriculum outcomes for Science and Social Studies can be found with the inquiry activities.

The Grass Won't Always be Greener Grade 8 Inquiry Investigation

Time frame:

4–6 weeks (This investigation can act as a platform from which to launch activities in the guidebook. Suggested timing is included in the inquiry steps).

Subject Integration

Interdisciplinary project for
Grade 8 Science and Grade 8 Social Studies
(see curriculum outcomes)

Materials:

- Waterscape Poster
- Climate Change Poster
  (Optional but very helpful resource – see Resources-Posters section at back)

Investigation designed for group work:

Create enough groups to research multiple solutions to the problem of reduced water resources. A group of four students will be "elected" at the start of the project. These students will represent the government and will be responsible for looking into provincial rules and regulations pertaining to water use, as well as devising a set of criteria by which to evaluate the various solutions from groups of students.

Final Product:

Each group will present their solution to a mock government committee. Presentations will be 5 minutes long.

Background Information:

As Canadians, it is easy to ignore the warning that we need to start conserving water. After all, we have the largest fresh water supplies on this planet. However, the time will come, especially in our relatively arid mid-western province, when we will face a very real water shortage. The challenge is to start doing something about it now and not wait until the problem becomes too overwhelming to deal with effectively. The problem students will need to solve is how to ensure a sustainable water resource for future generations. There will be two different sectors working on possible solutions: Conservationists will look for ways to reduce water use (industrial, agricultural, household); Technologists will look at alternative water sources (desalinating deep groundwater, importing water, recycling, etc.). After listening to presentations, the government committee will devise a plan based on the most feasible steps our province could take to ensure sustainable water.

Prompt:

Concentration is not necessarily a good thing. Take two beakers of the same size and fill one with water. Only half fill the other one. Drop the same amount of food colouring into each one and have students compare the colour. They will notice that the one with less water is more deeply coloured. Discuss what the implications are for our decreasing water supply in terms of how pollutants will be more concentrated as this precious resource declines. Continue on with the discussion, asking students to list other effects less water will have on life in the Bow River basin (food, health, quality of life, economics, environment, etc.).

Inquiry Phase	Process	Assessment Opportunities	Guidebook Activity
Planning	• Become familiar with the Bow River watershed using Waterscape poster • Become familiar with distribution of Earth's water, sources of water to recharge the Bow River watershed, and the ways the water is used • Become familiar with the Climate Change poster and how climate change could affect future water supplies (optional) • Choose a sector to represent — conservationist or technologist • Consider audience for final product sharing — elect government representatives • As a class, develop process checklist • Government committee starts thinking about criteria for product rubric	• Check understanding of inquiry process with student generated sequence chart • Journal entry — in order to assess understanding of potable vs. non-potable water, have students create an analogy of the concept in their journal	• Getting to Know the Bow • Haute Contour • Watershed Sculpture • Model in a Bottle
Retrieving	• Develop information retrieval plan (including Boolean search) • Use a variety of sources (professionals, articles, internet, encyclopedias, etc.) • Collect information on your chosen topic • Create your bibliography	• Check key words for Boolean search • Bibliography rubric • Rank sources from most helpful to least helpful	• Watershed Down • Water Use Challenge • Irritating Irrigating
Processing	• Devise information retrieval format (point form notes, mind map, visual graphic organizer, outline…) • Record relevant information • Use new knowledge to begin developing an original and creative solution to the problem.	• Evaluate approach used to record information • Vocabulary — list 10 words from unit of study relating to information • Journal entry — do you really believe your solution could solve a real-life water shortage? Explain.	• Go with the Flow • Please Don't Pass the Salt • All Bogged Down
Creating	• Revisit product rubric and obtain government evaluation criteria to make sure your solution will be acceptable. Revise as your group sees fit • Create a pros/cons chart to self-evaluate your solution. Revise as your group sees fit • Choose format — be creative (news story, model, demonstration, map, photographs, powerpoint, drama presentation, etc.) • Clearly explain the why and how of solution	• Groups offer constructive criticism of each other's solutions • Flow chart of planned presentation • Journal entry — response to peer feedback — positive or negative, changes that will be made based on feedback	
Sharing	• Communicate with audience (government officials), convincing them of merit and value of your solution • Demonstrate appropriate audience behaviour while others present.	• Exit slip — one thing learned, one question remaining • Effectiveness of visual aids	
Evaluation	• Evaluate product • Evaluate process	• Product rubric • Process checklist • Journal entry — agree or disagree with decision?	• Bow River Reflections

Curriculum Outcomes for The Grass Won't Always be Greener:

Grade 8 Science: Topic E – Freshwater and Saltwater Systems

STS and Knowledge

- **Outcome 1:**
  - distribution of water in Alberta, Canada and the world
  - fresh and saltwater contain varying amounts of dissolved matter
  - tests used to determine if water is potable
  - methods for creating fresh water from saltwater
- **Outcome 2:**
  - describe processes leading to the development of ocean basins and continental drainage systems
- **Outcome 3:**
  - seasonal, short term and long term changes in aquatic populations
  - relationship between water quality and living things
- **Outcome 4:**
  - human water uses and impacts resulting from different uses
  - current practices and technologies that affect water quality
  - environmental costs and benefits and evaluate alternatives
  - role of science in monitoring and developing environmental technologies
  - examples of problems that cannot be solved with science and technology alone

Skills

- Identify science related issues
- Identify questions arising from issues and problems
- Select appropriate methods for collecting relevant information
- Research information relevant to a given issue
- Interpret patterns and trends in data and infer relationships
- Identify new questions arising from what was learned
- Use appropriate vocabulary to communicate ideas
- Communicate questions, intentions, plans and results
- Evaluate individual and group processes
- Defend a given position based on findings

Attitudes

- Interest in science-related questions and careers
- Understanding evolves from ideas from different viewpoints
- Seek and apply evidence when evaluating approaches to problems
- Work collaboratively when evaluating ideas
- Understand balance between human needs and sustainable environment

Grade 8 Social Studies (New Curriculum)

Core Concepts of Citizenship and Identity:

- Understand the principles underlying a democratic society
- Demonstrate a critical understanding of individual and collective rights
- Understand the commitment required to ensure the vitality and sustainability of communities at the local, national, international and global level

Strands of the Social Studies Curriculum:

- Time, continuity and change — understand the past, make meaning of the present and make decisions for the future
- The land: Places and People — relationship humans have with the land, impacts of physical geography on social, political, environmental and economic organization
- Power, authority and decision making — how these relationships impact individuals, relationships, communities and nations. Understanding of an individual's capacity in decision-making processes through active and responsible citizenship
- Economics and resources — Exploring multiple perspectives on the use, distribution and management of resources. Affect of wealth and resources on quality of life. Social and environmental implications of resource use and environmental change
- Global Connections — multiple perspectives and connections and how they effect the interdependent or conflicting nature of individual, communities, societies and nations

Values, Attitudes, Knowledge and Understanding

- Topic 8.1 Isolation to Adaptation
  - 8.1.3 Appreciate how model of government reflects worldview
  - 8.1.4 How society's worldview affects citizenship and identity
- Topic 8.2 Origins of a Western Worldview
  - 8.2.3 Beliefs and values are shaped by time, location and context
- Topic 8.3 Worldviews in Conflict
  - 8.3.3 How rapid adaptation can radically change a society's beliefs, values and knowledge

Skills

- Develop skills of critical and creative thinking
- Develop skills of geographic thinking
- Demonstrate skills of decision making and problem solving
- Demonstrate skills of cooperation and consensus building
- Age appropriate behaviour for social involvement in the community
- Apply the research process
- Demonstrate skills of oral, written and visual literacy

The Mystery of Dirty Bow H_2O Grade 9 Inquiry Investigation

Time frame:
4–6 weeks (This investigation can act as a platform from which to launch activities in the guidebook. Suggested timing is included in the inquiry steps).

Subject Integration:
This is an interdisciplinary project for Grade 9 Science and Grade 9 Social Studies (see curriculum outcomes). The investigation is designed primarily for group work.

Materials:
- Waterscape Poster
- Access to Internet

Final Product:
Each group will present their findings to a mock government environmental committee. Presentations will be 5 minutes long. The environmental committee will consist of 5 students (randomly drawn names or however you wish to choose them). This committee will decide, based on the presentations, who is ultimately responsible for the pollution in Lake Newell.

Background Information:
Everyone in the Bow River Watershed is a neighbour, with great distances being bridged by the liquid lifeline running through the river valley. However, sometimes neighbours have misunderstandings. The town of Brooks has sent a complaint to the City of Calgary claiming that their wetland habitat at Lake Newall (which is partially fed by diverted irrigation water from the Bow River) is being polluted by the urban centre's effluent and storm sewer discharge. There has been a decrease in the dissolved oxygen levels and an increase in phosphate and nitrate levels in the lake water, leading to a decline in the diversity of species that make their home in this habitat. Because Calgary is the largest urban centre upstream of Brooks, they are the most likely suspect. As environmental scientists, your jobs will be to investigate the Brooks complaint. You will need to investigate Calgary's contribution to the problem and look at other possible contamination sources from Banff to Brooks.

Prompt:
You don't always see what is in your water. Place a baby food jar in a larger jar. Fill the larger jar and the baby food jar with baby oil, starting with the smaller jar and letting it overflow into the larger one. The baby food jar will disappear before student's eyes. Lead a discussion about how we might think the water we send on down the river is clean but, in actuality, it can have pollutants that can be very harmful to the environment. Out of sight, out of mind.…

Groups: (Based on Bow River Basin Council's Identified Reaches)

- **Group A** will be looking at the environment immediately around Lake Newell itself to determine any possible sources of pollution or other important factors. They can begin their search at:
  - http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
  - Atlas of Alberta Lakes Go to "Lakes of the Atlas", link to Quick Search "Lake Newell". Information includes Introduction, Drainage Basin Characteristics, Lake Basin Characteristic, Water Quality, Biological Characteristics, and References.

- **Group B** will be looking at Reach 3 (Banff National Park Boundary to Bearspaw Dam). Begin your search at:
  - http://www.brbc.ab.ca/reach3.asp where you can get a map. Information on this site includes reach description (what tributaries are included, geography, human impact and pollution sources), water quality information (including a synopsis of what is going on in towns along the way and any serious concerns), and ecosystem descriptions.

- **Group C** will be looking at Reach 4 (Bearspaw Dam to the Western Irrigation District Weir). Begin your search at:
  - http://www.brbc.ab.ca/reach4.asp

- **Group D** will be looking at Reach 5 (Western Irrigation District Weir to Highway 22X). Begin your search at:
  - http://www.brbc.ab.ca/reach5.asp

- **Group E** will be looking at Reach 6 (Highway 22X to Carseland Weir). Begin your search at:
  - http://www.brbc.ab.ca/reach6.asp

- **Group F** will be looking at Reach 7 (Carseland Weir to Bassano Dam). Begin your search at:
  - http://www.brbc.ab.ca/reach7.asp

- **Group G** will be looking at Reach 8 (Bassano Dam to Oldman River). Begin your search at:
  - http://www.brbc.ab.ca/reach8.asp

Other good sources of information include:

- www1.agric.gov.ab.ca (click on soil/air/water) – Alberta Government site has info on water quality issues from agricultural areas
- http://www.waterforlife.gov.ab.ca/ Water for life – Alberta government strategy for sustainability
- http://www3.gov.ab.ca/env/water/basins/basinform.cfm Alberta's river basins (Alberta government environment)
- http://www.ec.gc.ca/water/e_main.html Environment Canada Freshwater Website
- http://www.brbc.ab.ca/map.asp BRBC watershed map

Inquiry Phase	Process	Assessment Opportunities	Guidebook Activity
Planning	• Become familiar with the Bow River watershed using Waterscape poster • Become familiar with the water quality criteria you will be using • Choose a location to investigate with group • Consider audience for final product sharing • As a class, identify evaluation criteria – process checklist and product rubric	• Check understanding of inquiry process by having students make a sequence chart • Exit slip – one thing learned, one question remaining	• Getting to Know the Bow • Haute Contour • Watershed Sculpture
Retrieving	• As a class, brainstorm about what information you will need to obtain • Visit group website and discuss what additional info will be helpful • List key words for Boolean search • Create a bibliography of sources	• Whole class conversation • Journal entry – successes or frustrations finding information sources	• Watershed Down • Go with the Flow • Please Don't Pass the Salt • Flames Flushers
Processing	• Devise information retrieval format (point form notes, mind map, visual graphic organizer, outline…) • Record relevant information in your graphic organizer • Interpret findings, making inferences and connections when possible • Decide if your location is a contributor to the polluted lake	• Review organizer to ensure students are aware of major focus areas • Vocabulary – list 10 words from unit of study relating to information • Journal entry – relate new knowledge to something familiar	• Take a Bow, Calgary • Where Have All Flow-ers Gone? • Tasty Waste • What Goes In Must Come out • Bogged Down
Creating	• Revisit product rubric to make sure it fits with current progress • Create a cause/affect chart to summarize findings and ensure no further research is necessary • Choose format – be creative (news story, model, demonstration, map, photographs, powerpoint, drama presentation, etc.) • Product must convey information in a way that will allow committee members to have all the information they require to make a decision. Time: 5 minutes long	• Peer evaluation of first draft of product • Flow chart of presentation • Journal entry – response to peer feedback – positive or negative, changes that will be made based on feedback	
Sharing	• Communicate with audience (committee), convincing others of accuracy of your group's work • Demonstrate appropriate audience behaviour while others present	• Photograph of presentation for journal entry – best part, one thing you would change	
Evaluation	• Revisit process checklist – should anything be changed? • Evaluate product • Evaluate process	• Product rubric • Process checklist • Journal entry – feelings about the Bow, new questions, how personal understanding changed	• Bow River Reflections

Curriculum Outcomes for The Mystery of Dirty Bow H_2O

Grade 9 Science: Topic C – Environmental Chemistry

STS and Knowledge

- **Outcome 1:**
  - chemicals introduced to the environment
  - questions about safe amounts of substances in the environment
- **Outcome 2:**
  - chemical factors affecting health of living things
  - measuring concentrations of chemicals in the environment
- **Outcome 3:**
  - transfer of materials and factors affecting their distribution
  - interpret information on impact of chemicals on ecosystems
  - evaluate evidence gained from environmental chemistry

Skills

- Identify science related issues
- Identify questions arising from issues
- Identify data that is relevant to an issue
- Organize data using an appropriate format
- Evaluate strengths and weaknesses of displaying data
- Recognize and explain discrepancies in data
- Work cooperatively with team members to carry out a plan
- Receive, understand and act on the ideas of others
- Defend a given position on a problem based on findings

Attitudes

- Interest in science-related questions and careers
- Seek and apply evidence when evaluating alternative solutions
- Work collaboratively when generating ideas and solutions
- Aware of balance between human needs and a sustainable environment

Grade 9 Social Studies (New Curriculum)

Core Concepts of Citizenship and Identity:

- Understand the principles underlying a democratic society
- Demonstrate a critical understanding of individual and collective rights
- Understand the commitment required to ensure the vitality and sustainability of communities at the local, national, international and global level

Strands of the Social Studies Curriculum:

- Time, continuity and change – understand the past, make meaning of the present and make decisions for the future
- The land: Places and People – relationship humans have with the land, impacts of physical geography on social, political, environmental and economic organization
- Power, authority and decision making – how these relationships impact individuals, relationships, communities and nations. Understanding of an individual's capacity in decision-making processes through active and responsible citizenship
- Economics and resources – Exploring multiple perspectives on the use, distribution and management of resources. Affect of wealth and resources on quality of life. Social and environmental implications of resource use and environmental change.
- Global Connections – multiple perspectives and connections and how they affect the interdependent or conflicting nature of individual, communities, societies and nations.

Values, Attitudes, Knowledge and Understandings

- Topic 9.1 Issues for Canadians: Governance and Rights
  - 9.1.2 Impact of government policy on Canadian society
  - 9.1.3 How emerging issues affect quality of life in Canada
- Topic 9.2 Issues for Canadians: Canadian and U.S. Economics
  - 9.2.2 Relationship between consumerism and quality of life
  - 9.2.3 Impact of government decisions on quality of life
  - 9.2.5 How does individual consumer behaviour affect quality of life
  - 9.2.6 Impact of government decisions on environment on life

Skills

- Develop skills of critical and creative thinking
- Develop skills of geographic thinking
- Demonstrate skills of decision making and problem solving
- Demonstrate skills of cooperation and consensus building
- Age appropriate behaviour for social involvement in the community
- Apply the research process
- Demonstrate skills of oral, written and visual literacy

Getting to Know the Bow

Subjects:

Fine Arts, Language Arts, Science, Social Studies

Time:

1–2 class periods. This is an introductory activity for the unit of study.

Objectives:

In order to "meet" the Bow River on a more personal level, students can do an activity involving creation of a metaphor through personification. Authentic works of art depicting the Bow River will be used to broaden student's interdisciplinary perspective as they work through the various activities in this guide book.

Materials:

- Various pictures (photographs or paintings/drawings) of the Bow River in different seasons
- A good resource is "The Bow. Living with a River" (Book or art prints available at the Glenbow Museum Gift Shop)

Procedure:

If you are using The Bow: Living with a River, this would be a good time to discuss the first section (From Serendipity to Reality) as a way of introducing the Bow as a popular subject with artists.

Prompt:

In order to ensure that students are comfortable with the idea of personification, the following activity can be done at the start of the lesson. Ask students to list several nouns (relating to anything but humans). Write these in one column on the board. In another column, write down verbs (anything that does relate to what humans do). Students will then choose one word from each column and incorporate them into the sentence "The noun verb(ed)." For example, "The volcano belched", or "The car sighed". Once they have their sentence, they have two minutes to illustrate it and then two minutes to share with others.

Fig. 6

ACTIVITY:

1. Divide students into three groups (number off or whatever method works well for the class). Each group will be looking at a different piece of artwork depicting the Bow River. You should have enough copies of each picture so that no more than four students have to share.

2. Allow students to silently reflect on their picture for two minutes (there should be no talking at this stage).

3. Ask students to discuss whether they like or dislike the picture with one other person in their group (or two if there is an odd number).

4. Each group will answer the following questions about their picture. Students are encouraged to be creative, take turns with ideas and reach consensus: (you may want to put these questions on a worksheet to make recording answers easier)

    - What do you see (colours, lines or shapes that stand out)? Decide on three words and write them down.

    - What feelings, sensations or emotions do you have? Decide on three words and write them down.

    - If this work of art were illustrating a story, what genre could it be? Decide on three words to write down.

    - What personality traits does the work of art convey? Decide on three words to write down.

    - Describe three different things this artwork might do (occupation, hobby, role in the family, etc.) if it were a person and explain why. "This artwork might _______ because _______". Encourage students to be creative, use strong adjectives and refer back to the picture. For example, "This artwork might be a professor because the content is disorganized, it is focused on one main idea and it clearly wants to teach a lesson".

5. All students who looked at the same picture regroup and choose one of the roles the picture might play. Based on that role, they create a monologue for it by writing a paragraph about what it is thinking, saying and doing.

6. Three students are chosen, one for each of the three pictures and they are invited up for an impromptu dialogue about the issue of global warming (or any other topic). These students must consider the personality of their work of art, its role, and how it would interact and respond to the other personalities.

7. Students will reflect on what they have learned in their personal journals. Questions might be:

    - When, during this lesson, did you feel that "AHA" moment when you suddenly saw the work of art in a new light?

    - How has this activity changed your feelings about the work of art and about the Bow River? What do you see or feel that you did not before?

    - Do you think the Bow River actually has different personalities? Explain why or why not.

Bow River Basin Panel Activities

BACKGROUND INFORMATION

What is the Bow River basin?

A river basin or watershed is high at its edge, and low in the centre where the river flows. The Bow River basin or watershed includes all the land that feeds water to the Bow River and its tributaries.

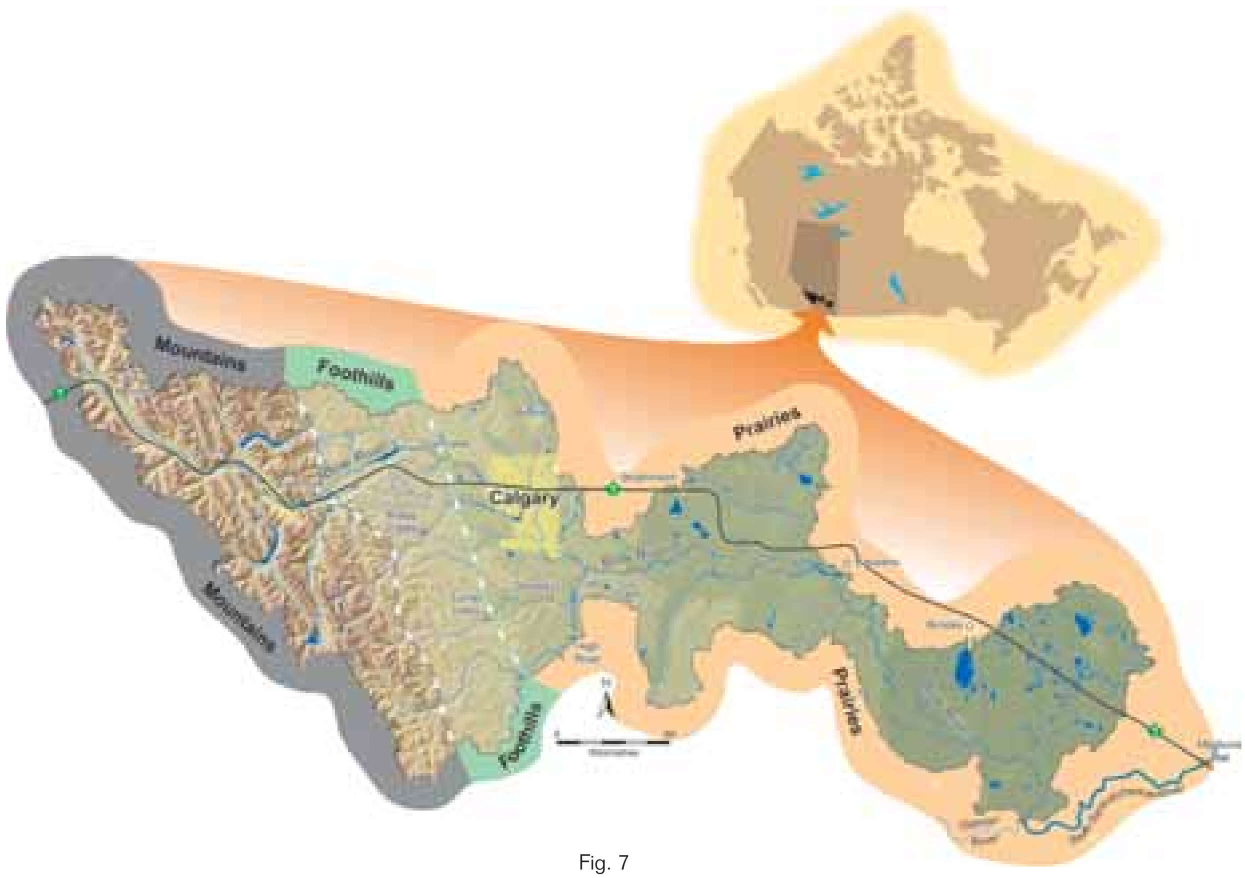


Fig. 7

Mountains, foothills, and prairies

Most Bow River waters come from the Rocky Mountains, an area largely protected within parks.
East of the mountains, the Bow River flows through foothills, and then through rolling prairie. The Bow River also flows through the City of Calgary, home to most of the basin's human residents.

Who lives here? Over a million people...and growing fast!

The Bow River basin is the most densely populated river basin in Alberta. There is less water available per person here than any other river basin in the province. And yet, in the last ten years, the population of the basin has grown by over a quarter of a million people. So we have a challenge!

Fig. 8

An ancient homeland

The lands of the Bow River basin have been home to First Nations people for thousands of years. Today, the Stoney Nakoda Nation has reserve lands throughout the foothills of the Bow River basin. Tsuu T'ina Nation reserve lands extend west from Calgary to Bragg Creek, and the Siksika Nation reserve lands straddle the Bow River valley near Bassano.

Haute Contour

Subjects:
Science, Social Studies

Time:
3–4 class periods (2+ class periods to create models, 1 class period to colour a topographic map

Objectives:
- Identify how topography determines the flow of water through the environment
- Illustrate the Bow River Basin using different strategies (3-D model, 2-D topographic map)

Procedure:

PART A: Building a 3-D model of the Bow River headwaters
This model activity can be carried out using either plasticine or craft foam sheets to create the contour intervals. The materials list varies depending upon which medium is chosen. This activity lends itself well to small groups, dividing the individual tasks (contour intervals) amongst group members.

Materials for Plasticine Model (enough for 1 model):
- BLM handouts of Contour Intervals: dark green (Fig. B1), yellow (Fig. B2), orange (Fig. B3), red (Fig. B4), and lakes (Fig. B5)
- cookie sheet (8.5” x 11”)
- scissors
- rolling pin
- plasticine: light green (550g), dark green (350g), yellow (300g), orange (150g), red (pinch), blue (pinch)
- wax paper
- Topographic map for Bow Glacier model BLM (Fig. B6)
- Optional: Water Works (City of Calgary Waterworks)

Materials for Craft Foam Model (enough for 1 model):
- BLM handouts of Contour Intervals: dark green (Fig. B1), yellow (Fig. B2), orange (Fig. B3), red (Fig. B4), and lakes (Fig. B5)
- scissors
- craft foam of equal thickness (8.5” x 11”): light green (1 sheet), dark green (1 sheet), yellow (1 sheet), orange (1 sheet),
- red, blue, and black permanent markers (i.e. Sharpie)
- white glue
- Topographic Map for Bow Glacier Model BLM (Fig. B6)
- Optional: Water Works (City of Calgary Waterworks)

Prompt (from The City of Calgary Waterworks):
Water Works Teacher’s Guide: Ask the students where does the water come from? Which direction does the water flow? The Bow River’s headwaters are high up in the Rocky Mountains at the Bow Glacier. The river flows down through the foothills, through Calgary and eventually joins the South Saskatchewan River near Taber, Alberta. When measured from its headwaters (at Bow Glacier) to the point where it joins the South Saskatchewan River, the Bow is 623 km long. The Bow River Watershed covers all land that has streams and rivers that flow into the Bow River. The Bow River Watershed is 7800 square km. Show the students the Bow River Basin image on the poster and introduce the vocabulary.

To build the model, the students need to build it bottom to top or lowest to highest contour interval. Also, when building the model, students must realize they are dealing with evenly spaced contour intervals (elevations), so each plasticine layer should be of equal thickness. Contour intervals represent different elevations and never intersect, so each plasticine or craft foam layer rests completely over another layer without spilling over the colour that lies below it.

ACTIVITY (PLASTICINE):

1. The first contour interval is below 2000 ft, which will be the light green colour. The light green plasticine will be used to entirely fill an 8.5”x11” surface on the cookie sheet because it is the lowest contour interval. Students may find wax paper and a rolling pin helpful in spreading out the plasticine evenly or they may prefer to press it out with their fingers.

2. The second contour interval is between 2000–2300 ft, which will be the dark green colour. Students will need the Dark Green Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be filled with dark green plasticine. Press the plasticine evenly and of equal thickness over top the white areas. Carefully, peel off the paper from the plasticine and gently place over top the light green plasticine in the cookie sheet, referring to the Bow Glacier topographic map for proper contour interval placement.

3. The third contour interval is between 2300–2600 ft, which will be the yellow colour. Students will need the Yellow Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be filled with yellow plasticine. Press the plasticine evenly and of equal thickness over top the white areas. Carefully, peel off the paper from the plasticine and gently place over top the dark green plasticine in the cookie sheet, referring to the Bow Glacier topographic map for proper contour interval placement. Remember, do not let the yellow spill over the dark green onto the light green.

4. The fourth contour interval is between 2600–2900 ft, which will be the orange colour. Students will need the Orange Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be filled with orange plasticine. Press the plasticine evenly and of equal thickness over top the white areas. Carefully, peel off the paper from the plasticine and gently place over top the yellow plasticine in the cookie sheet, referring to the Bow Glacier topographic map for proper contour interval placement. Remember, do not let the orange spill over the yellow onto the dark green. Also, there are many pieces involved in this interval so extra care must be taken.

5. This is a very small contour interval with only 2 small pieces involved, requiring very little plasticine. This contour interval is over 2900 ft, which will be the red colour. Students will need the Red Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be filled with red plasticine. Press the plasticine evenly and of equal thickness over top the white areas. Carefully, peel off the paper from the plasticine and gently place over top the orange plasticine in the cookie sheet, referring to the Bow Glacier topographic map for proper contour interval placement. Remember, do not let the red spill over the orange onto the yellow.

6. To create the lakes, use the Lakes BLM. Have the students cut out the labelled lakes and place the lake cut-out shapes onto the model, over the light green plasticine, in the correct positions referring to the Bow Glacier topographic map. Trace the shape of the lakes into the plasticine, and then carefully scrape the inside of the lake shape out of the light green plasticine, so a depression is created. Fill the depression with blue plasticine, to simulate the two lakes.

7. Looking at the models, have students find the highest points and lowest points. Have them locate the valleys carved out by ancient glaciers.

8. How do the contour lines relate to contour intervals? What may have been observed if more contour lines were used to create the models?

ACTIVITY (CRAFT FOAM):

1. The first contour interval is below 2000 ft, which will be the light green colour. An 8.5”x11” light green craft foam shape will be used as the base because it is the lowest contour interval. All other colours will be glued on top. No cookie sheet is necessary.

2. The second contour interval is between 2000–2300 ft, which will be the dark green colour. Students will need the Dark Green Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be used to trace the shapes onto the dark green craft foam. Once the image has been traced onto the foam, it can be cut out and placed over top the light green craft foam, referring to the Bow Glacier topographic map for proper contour interval placement. Glue in place.

3. The third contour interval is between 2300–2600 ft, which will be the yellow colour. Students will need the Yellow Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be used to trace the shapes onto the yellow craft foam. Once the image has been traced onto the foam, it can be cut out and placed over top the dark green craft foam, referring to the Bow Glacier topographic map for proper contour interval placement. Glue in place. Remember, do not let the yellow cross over the dark green onto the light green.

4. The fourth contour interval is between 2600–2900 ft, which will be the orange colour. Students will need the Orange Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be used to trace the shapes onto the orange craft foam. Once the image has been traced onto the foam, it can be cut out and placed over top the yellow craft foam, referring to the Bow Glacier topographic map for proper contour interval placement. Glue in place. Remember, do not let the orange cross over the yellow onto the dark green. Also, there are many pieces involved in this interval so extra care must be taken.

5. This is a very small contour interval with only two small pieces involved, requiring very little craft foam. This contour interval is over 2900 ft, which will be the red colour. Students will need the Red Contour Interval BLM. Have the students cut out the black area and keep only the white areas, which will be used to trace the shapes onto the leftover orange craft foam. Once the image has been traced onto the foam, it can be cut out, coloured with a red permanent marker (including the edges) and placed over top the orange craft foam, referring to the Bow Glacier topographic map for proper contour interval placement. Glue in place. Remember, do not let the red cross over the orange onto the yellow.

6. To create the lakes, use the Lakes BLM. Have the students cut out the labelled lakes and place the lake cutout shapes onto the model, over the light green craft foam, in the correct positions, referring to the Bow Glacier topographic map. Trace the shape of the lakes onto the craft foam, then carefully colour the lakes with a blue permanent marker.

7. Lakes and rivers can be labelled with permanent markers.

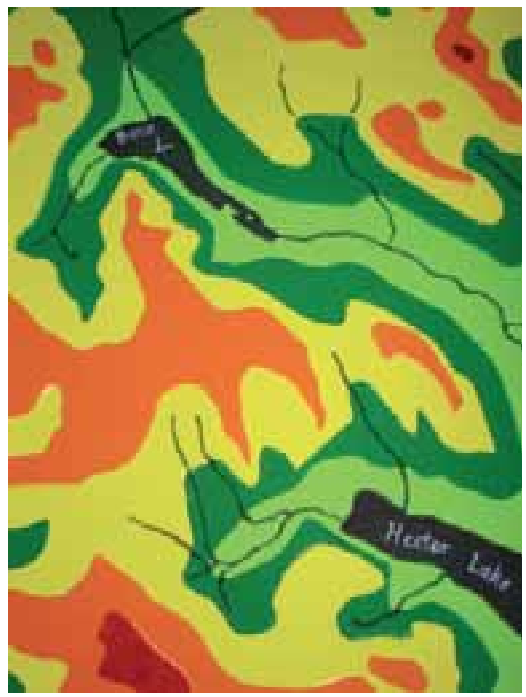
8. Looking at the models, have students find the highest points and lowest points. Have them locate the valleys carved out by ancient glaciers.

9. How do the contour lines relate to contour intervals? What may have been observed if more contour lines were used to create the models?

Extensions:

- Contour lines can be labelled with toothpicks and flags at the base of each interval. Also, a 3-D model using other materials could be created.
- The next time students are passing through British Columbia on the Trans Canada Highway, they may want to stop at the Continental Divide. Not only does the Continental Divide mark a difference in time zones between Alberta and British Columbia, it also marks a difference in water flow. To the west of the divide, water flows towards the Pacific Ocean and to the east, it flows through the Bow River, the South Saskatchewan River and eventually into Hudson Bay. That is the Bow River's amazing journey.

Haute Contour Part A – Plasticine Model 1
Fig. 9



Haute Contour Part A – Craft Foam Model
Fig. 10

Dark Green Contour Interval BLM

Figure B1

Yellow Contour Interval BLM

Figure B2

Orange Contour Interval BLM

Figure B3

Red Contour Interval BLM

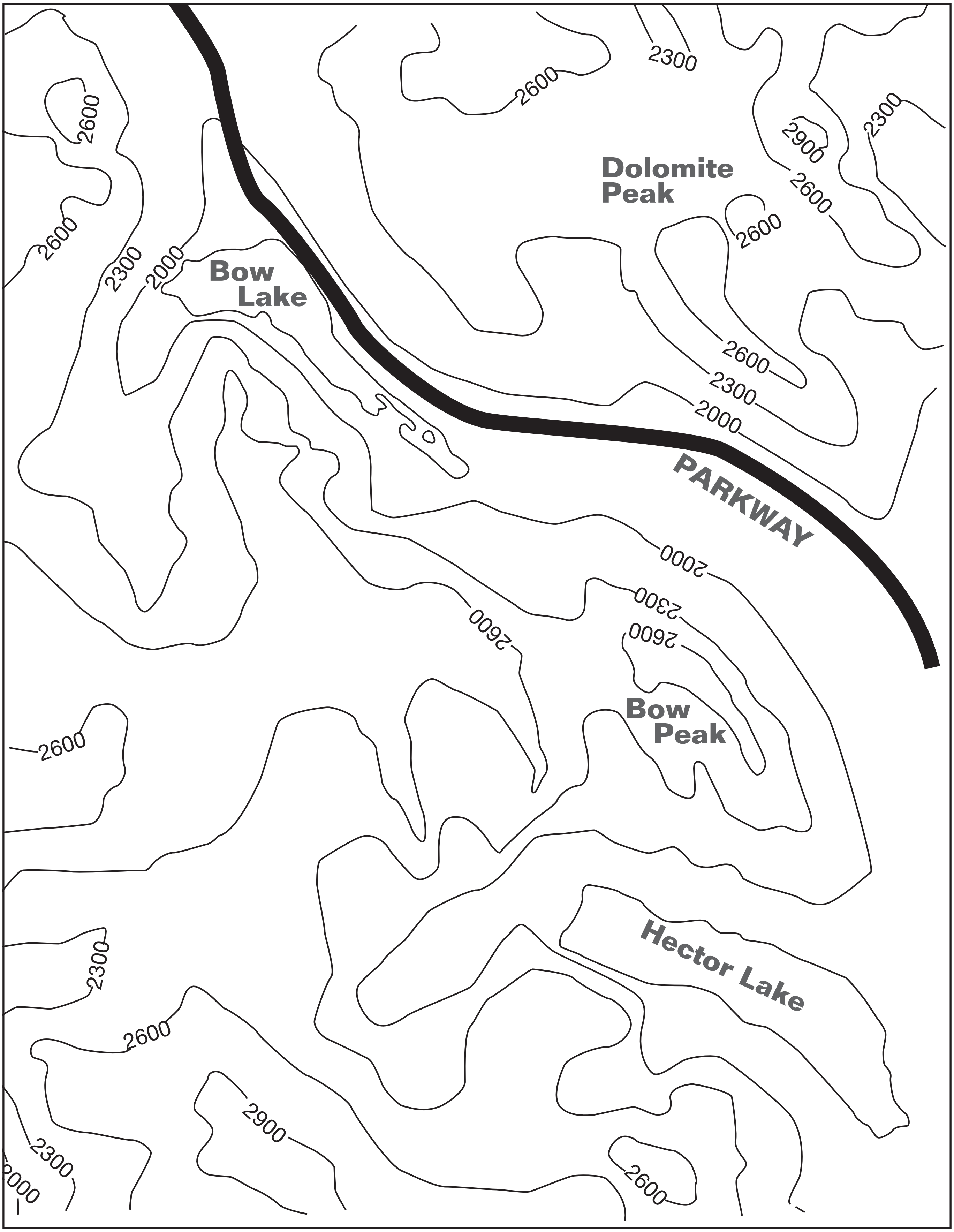
Figure B4

Lakes BLM

Figure B5

Topographic Map for Bow Glacier Model

Figure B6



PART B: Colouring a topographic (topo) map of the Bow River headwaters

By now students have a better understanding about contour lines based on the visual model. Students can appreciate what the contour lines represent on a topo map and using the same colour scheme from the previous activity, they can colour a 2-D topo map of the Bow River headwaters. This map is more detailed than the one used to construct the model and the original topo map is even more detailed.

Materials:

- Bow River Headwaters Topographic Map BLM (Fig. C1 – one per student)
- copy of Original Topographic map of Bow River Headwaters BLM (Fig. C2 – for comparison purposes only; a transparency copy to show the entire class would suffice)
- pencil crayons (light green, dark green, yellow, light orange, dark orange, red, purple, blue)
- red, blue overhead transparency pens
- Bow River headwater map key (Fig. C3)

PROCEDURE:

Prompt:

Show on the overhead projector, a copy of the original topographic map of the Bow River headwaters. Students may be overwhelmed by all the lines they see. Are there similarities between the models created and the lines on the original topo map? Use a red overhead transparency pen to outline some of the contours used to create the models. Do they see more similarities now? Use a blue overhead transparency pen to outline the lakes and rivers? Why would a topographic map be useful to someone hiking in the woods, riding a mountain bike, flying an aircraft or someone studying the local rock formations (geologist)? In this activity, students will use a simplified version of the original topo map to colour the individual contour intervals to better understand topo maps.

ACTIVITY:

1. Distribute a copy of the Bow River Headwaters Topographic Map BLM for each student.

2. Using the same systematic approach as used in the model activity have students create a key for the colours to be used and label them, on the back of the topo map. For uniformity and simplicity, use the following colour scheme but other colours may be used, as long as they are clearly labelled in the key:

   3000–3200 feet: red
   2800–3000 feet: dark orange
   2600–2800 feet: light orange
   2400–2600 feet: yellow
   2200–2400 feet: light green
   2000–2200 feet: dark green
   1800–2000 feet: purple

3. Beginning with the lowest interval, have students colour between the 1800–2000 ft interval in purple; the lakes can be coloured blue.

4. Next, have students colour the interval between 2000–2200 ft in dark green, and so on, with every colour in a systematic approach to avoid confusing contour lines. Remind students they must stay within the lines of each contour interval, just as was done in creating the model.

5. When completed, students can compare their coloured topo map with the models created. A comparison chart can be made comparing the 2-D and 3-D topo maps. How are they similar? How are they different? Which map is more practical? Why? Which map is easier to see valleys and rivers? Why? Where would the tributary streams and rivers form? (Remember: water always flows downhill).

6. Revisit the question from the prompt: why would a topographic map be useful to someone hiking in the woods, riding a mountain bike, flying an aircraft or someone studying the local rock formations (geologist)? There should be deeper understanding now, than at the start of the lesson.

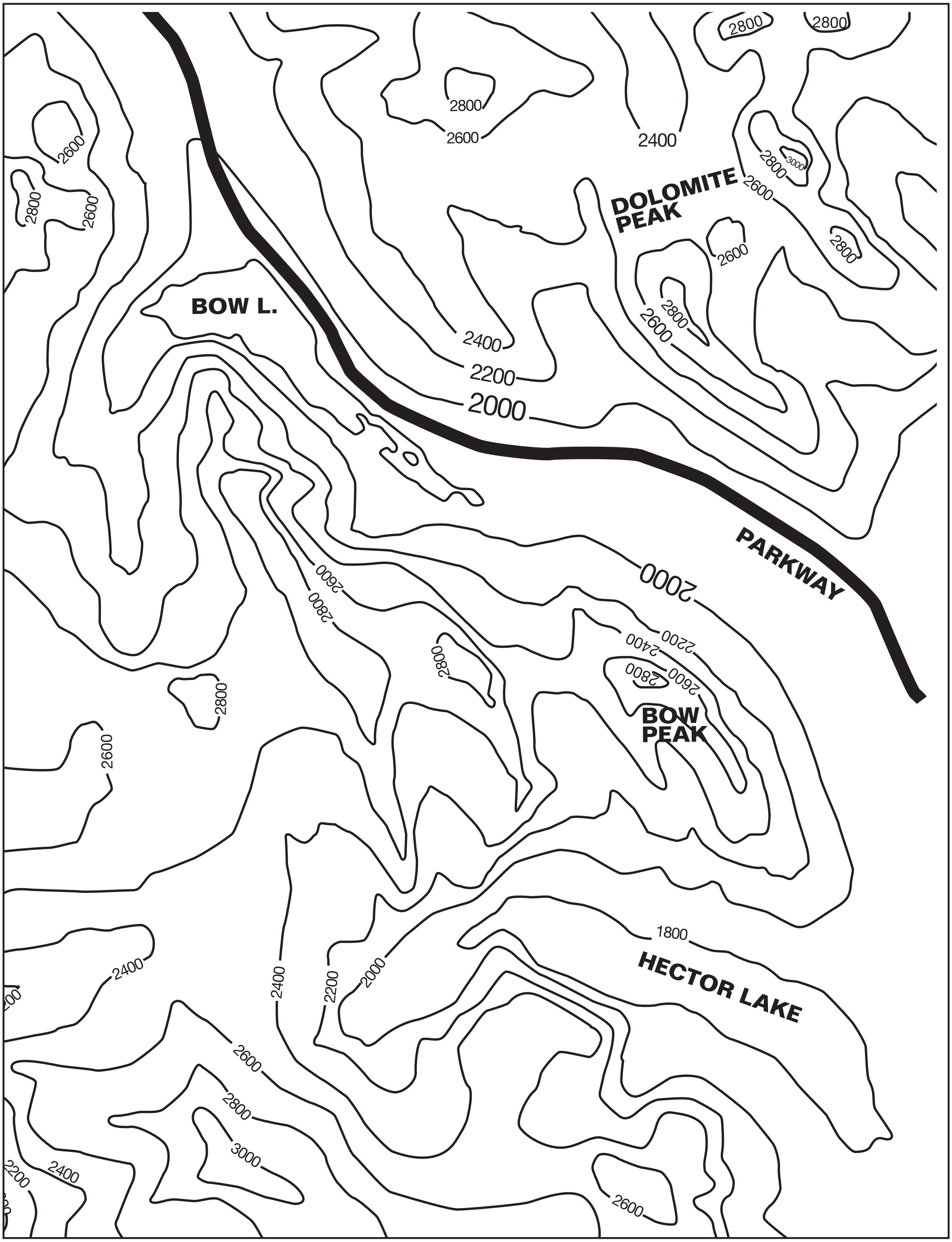
Extensions:

- Revisit the original topo map and compare it to the maps the students coloured. What features disappeared in the simplified topo map? Which map is more accurate? Why?

- Have students compare the contour topographic map to a relief map (Bow River Basin image or maps of geography in an atlas). How are they similar? How are they different? What colours are typically used in relief maps? Why? What are the benefits of each type of map?

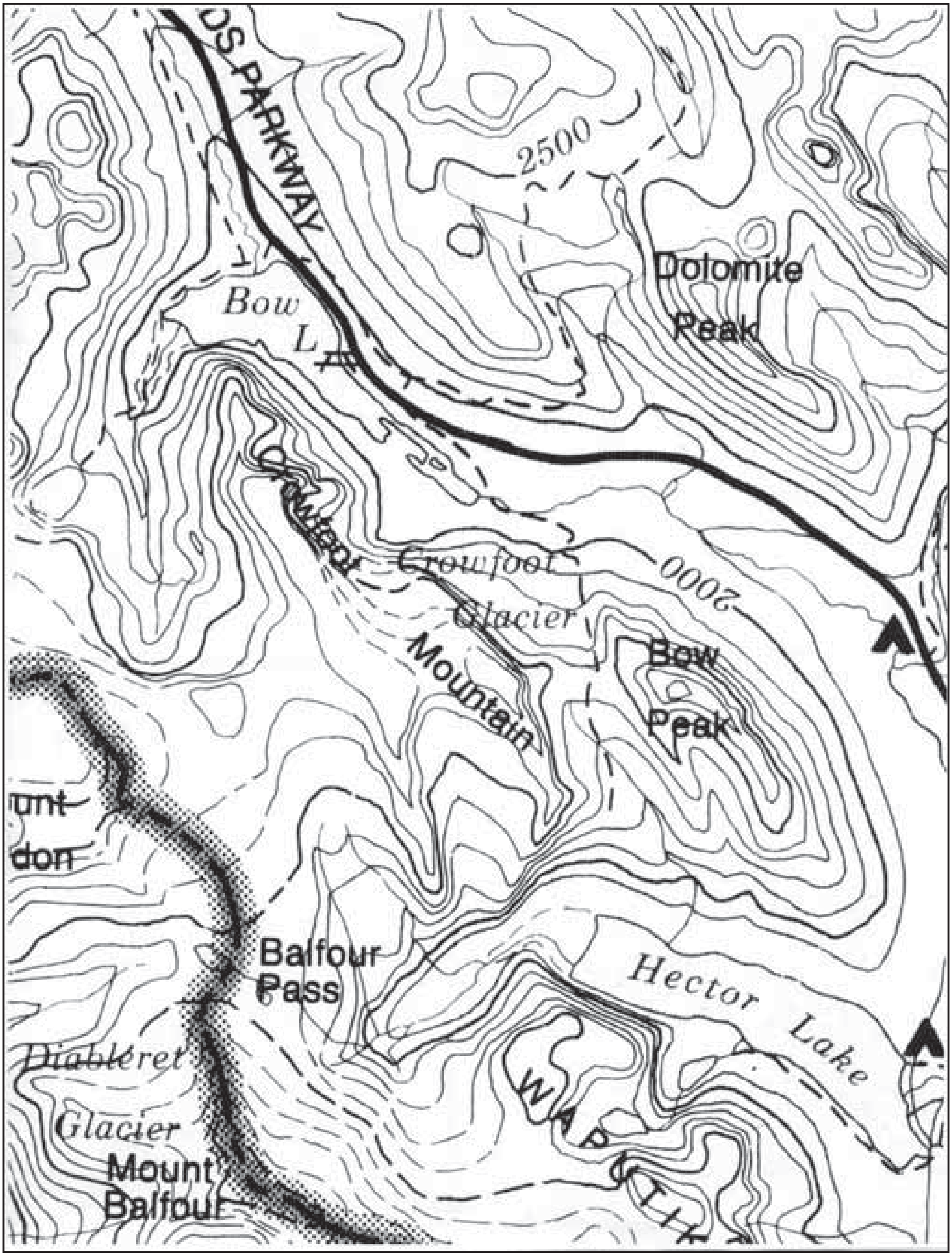
Bow River Headwaters Topographic Map BLM

Figure C1



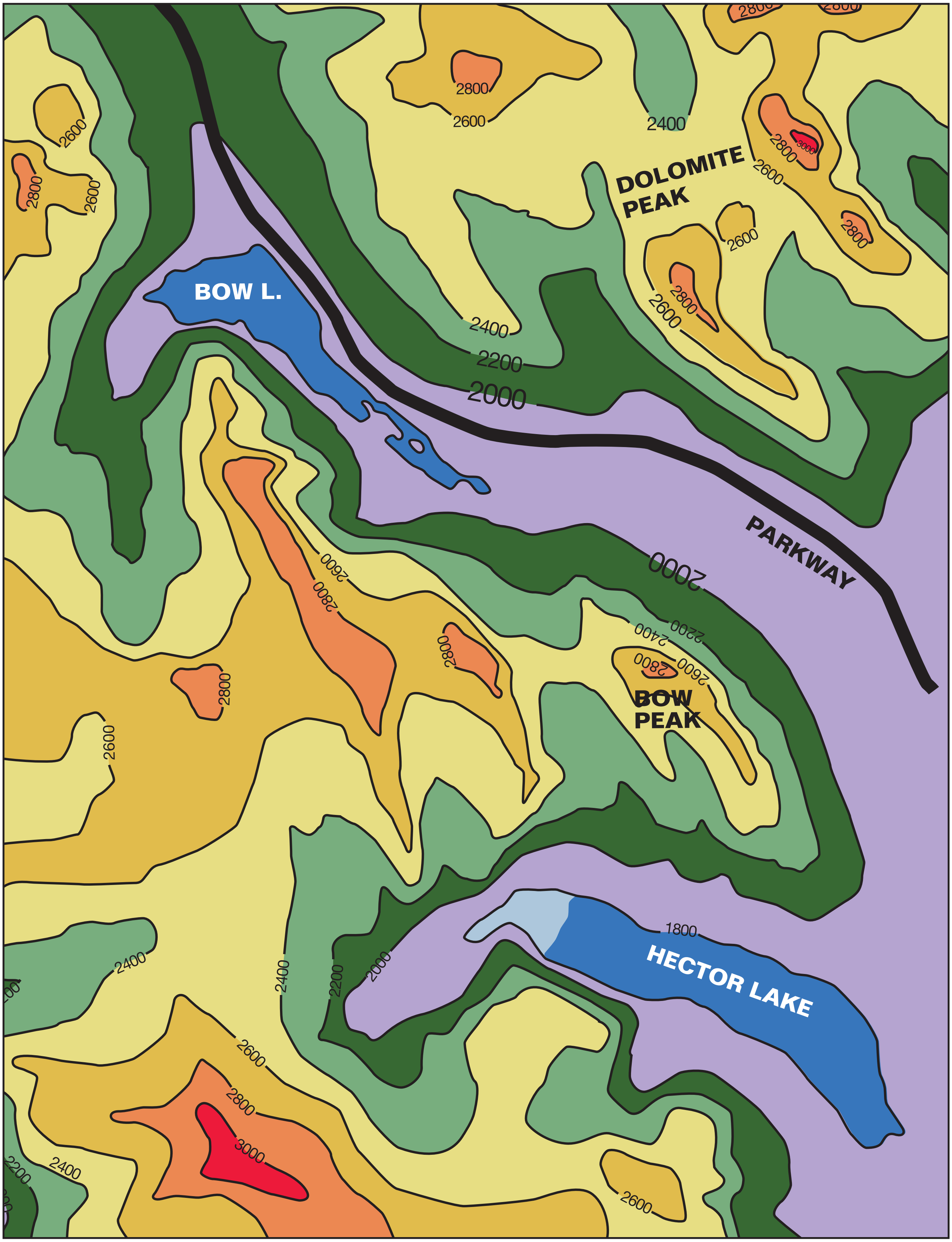
Original Topographic Map of Bow River Headwaters BLM

Figure C2



Bow River Headwaters Map Key

Figure C3



Watershed Sculpture

Subjects:

Science, Social Studies

Time:

2–3 class periods

Objectives:

- Identify how topography determines the flow of water through the environment.
- Identify and learn about the Bow River watershed's unique shape.
- Identify which communities share the Bow River Basin.
- Identify the shared responsibility each citizen has to maintain this resource.

Materials (enough for 1 model):

- Bow River Basin Waterscape poster (central image)
- hot glue gun (caution, teacher supervision) and glue gun sticks (4)
- cookie sheet or aluminum oven sheet (large)
- washed gravel (assorted) or other materials available
- Sharpie markers (red, blue, black)
- heavy duty aluminum foil (large roll)
- brown or black shoe polish and soft cloth/ paper towel (optional)
- cup with water

PROCEDURE:

Prompt:

This activity doesn't need a prompt to be interesting and it lends itself well to small group work, dividing the individual tasks amongst group members. Students will build a model of the entire Bow River Basin to show the direction of water flow and the unique shape it has.

ACTIVITY:

1. Give each group an aluminum oven sheet. Using a pencil, draw the outline of the watershed, referring to the poster's image. Draw the basin as large as possible. Outline the watershed in black permanent marker. Mark the north, south, east, and west directions on the model. Also, mark the location of Calgary and any other location of interest. Note: The basin is wider east to west, than north to south, and it has a very small corridor roughly in the middle.

2. Next, gather a variety of materials (stones of varying sizes) and sort according to size. Line the entire edge of the basin with the gravel, placing larger pieces closer to the headwaters (westernmost side) with smaller and smaller pieces progressively to the east.

3. Carefully apply hot glue (glue gun) to the bottom of the pebbles and lay them carefully back in place.

4. Observe the main tributaries of the Bow on the poster image. Choose a few main tributaries and use pebbles to define where these rivers are on the model. Again, carefully apply hot glue (glue gun) to the bottom of the pebbles and lay them carefully back in place. Remember, pebbles define the high areas, not the rivers themselves; therefore, two rows of pebbles with a groove in between defines a river.

5. Give each group a piece of heavy-duty aluminum foil, large enough to cover the entire model. Students will carefully press and shape the foil onto their model, taking extra care around the edge of the basin and in shaping the rivers.

6. Using a black permanent marker, outline the outer shape of the Bow River Basin, taking care not to break through the aluminum foil. Students can outline the shape of Calgary, and any other locations of interest in red permanent marker. Using

a blue permanent marker, students can draw the Bow and Hector Lakes (the headwaters), the main tributaries, and the Bow River from west to east.

7. Optional: to make the aluminum less reflective and the model look more realistic, students can take small amounts of shoe polish (brown/black) and run the polish over the aluminum into the creases. The model will take on a weathered look.

8. The model can be slightly raised on the west side, with books. Then a student can carefully pour water on the western most part of the model (headwaters) and students can watch the water collect from the various tributaries into the Bow River, travel through Calgary, along a narrow corridor and then southeast into the South Saskatchewan River.

9. Follow-up with some questions: What communities lie upstream from Calgary? Downstream from Calgary? How does the shape of the watershed control the flow of water?

Extension

- Research how many people live within and depend upon the Bow River Watershed. The watershed extends over a large area; how is it used? Refer to the poster.
- What would happen if a toxic spill occurred upstream from Calgary? How would this affect the drinking supply? What measures could be taken to protect the watershed from further damage?


Watershed Model Step 1 (Fig. 11)


Watershed Model Step 2 & 3 (Fig. 12)


Watershed Model Step 4 (Fig. 13)


Watershed Model Step 5 & 6 (Fig. 14)


Watershed Model Step 7 (Fig. 15)

The Water Cycle in Bow River Basin Panel Activities

BACKGROUND INFORMATION

Our mountain cloud catchers

Almost all the water in the Bow River comes from the Rocky Mountains. This mountain chain forces air to rise and cool, causing moisture to condense and fall as rain or snow. This precipitation, together with the meltwaters from glaciers that release ancient snowfalls, feed the Bow River through its many mountain tributaries. Even groundwater that feeds the Bow River begins its life as rain or snow.

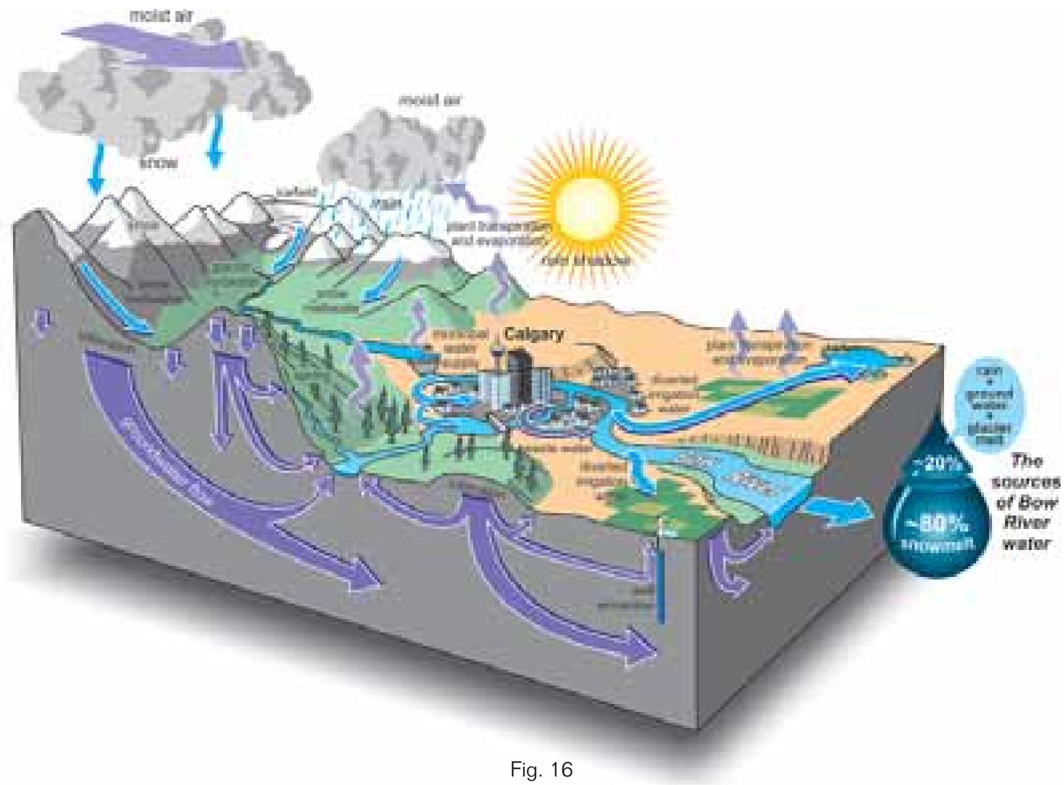


Fig. 16

Prairie lands: living in the rain shadow

So effective are the Rocky Mountains at stripping moisture from eastward moving air masses that little is left for the prairie areas, creating a "rain shadow." This is why irrigation is vital to agriculture; the Bow River is the most dependable source of water.

Fig. 17

Storing our water: nature's water towers and cisterns

Water flows the entire length of the Bow River in less than two weeks. Why then doesn't the Bow River dry up between rainstorms? Because nature stores and slowly releases water throughout the basin. Water is stored in snow packs, glaciers, wetlands, lakes and groundwater.

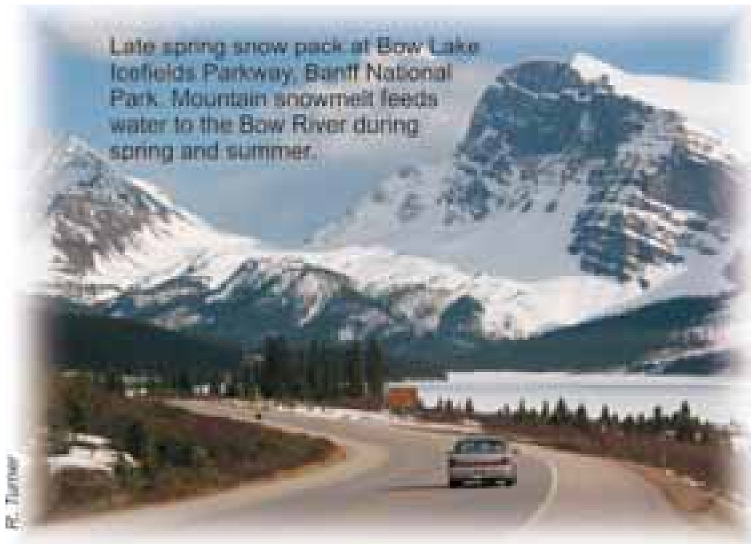


Fig. 18

No glaciers? What then?

Many people wonder what will happen to the river if the glaciers melt away? In fact, glacier meltwaters contribute less than 1% of the total annual flow to the Bow River so their overall contribution is small. However, the portion of Bow River water derived from glaciers rises during the summer as snowmelt wanes. During a drought year with reduced snowfall and rain, the relative contribution of glacier melt water to the Bow River is higher. Without glaciers in the Bow River basin, water supply during drought years would be much more challenging. However, as long as it snows and rains every year, we can expect the river to keep moving.

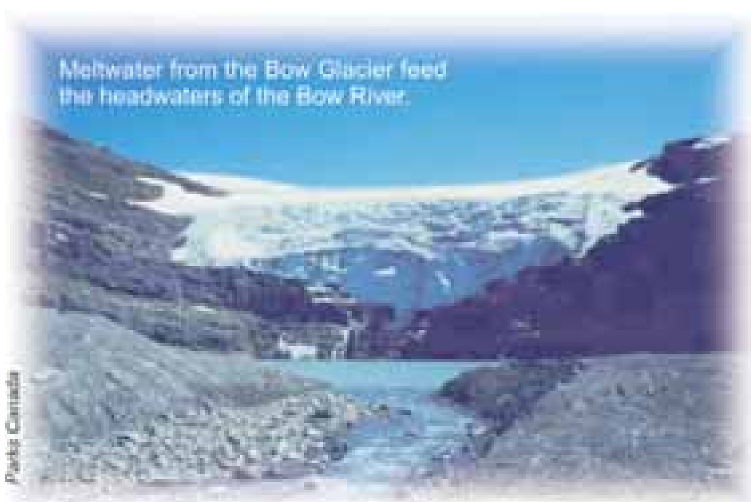


Fig. 19

Water Cycle: Model in a Bottle

Subjects:
Science, Language Arts

Time:
Building – one class period,
Observing – over several days

Objectives:
Students will gain an understanding of the interrelatedness between atmospheric water, groundwater and surface water. Students will better understand the roles of evaporation, condensation and transpiration in the water cycle.

Materials:
Enough for one water cycle model. If students are working in groups, each group can make their own model from which to make observations.

- Three 2-L clear plastic bottles
- Three bottle caps
- Marker
- Scissors
- Awl or nail
- 1 meter cotton string
- Masking tape
- 500 mL (2 cups) water
- 250 mL (1 cup) slightly moist potting soil
- Several fast-growing plant seeds (grass, beans or radishes work well)
- 10 ice cubes
- Drinking bird or celery – optional for prompt

PROCEDURE

Prompt:
Older teachers will remember when the drinking bird was a popular fad. Younger teachers have probably seen it on Homer Simpson's desk. Little does he know how wonderfully scientific this toy is! When the bird is set up with its water, it will tip over, appear to drink, and then stand up when it has "had its fill". How it works: The fluid is methylene chloride (paint stripper) which evaporates at a very low temperature. When the head gets wet, water evaporates and the head cools. The vapour inside the head also cools which lowers the pressure, allowing the fluid in the body to begin rising up since the pressure is greater down there. Dippy becomes top heavy and bends over. Vapour bubbles from the abdomen then rise to the head, displacing the fluid and pushing it back down toward the abdomen so the bird stands back up. This is similar to the process of transpiration. Putting celery in coloured water also shows transpiration when the leaves turn colour after a few hours. Lead a discussion on how water is moving in the bird or the celery, what represents groundwater, what represents leaves in the bird, etc. Students are now ready to put all of the pieces of the water cycle together as they build their model.

Building the Water Cycle Model:

1. Remove labels from three 2-L clear plastic pop bottles. Save the lids.
2. Draw a line around the top ridge of Bottle A. Cut around the line so that you have the "body" portion of the bottle.
3. For Bottle B and Bottle C, draw the line on the lower ridge. Cut around the lines so you have the "head, shoulders and body" portion of the bottle (upper 2/3 of bottle).
4. Bottle B:
   - Poke a hole in a cap using the awl or nail.
   - Cut 50 cm of cotton string
   - Fold string in half and thread loop through the hole in the cap, leaving at least 5 cm of string from each end hanging down.
5. Bottle C:
   - Place a cap with no hole on Bottle C.
   - Tie 30 cm of string around the bottle neck. Trim short end close to knot.
   - Tape string onto cap so that the end drops down from the centre of the cap. You will probably need to trim this so that it sits neatly in the collector cap in part B.
6. Assemble the bottles as shown in the diagram. These sections will be referred to as groundwater, surface water and atmospheric water.

Atmospheric water (Bottle C) with ice cubes (such as the cold layer of air above the Rockies). Only use ice cubes when demonstrating. Layer C will still provide greenhouse effect for Layer B.

Surface water (Bottle B) with 250 mL potting soil and plants started from seed. Soil should just cover the top of the loop. Place an upside down cap on the surface of the soil. The string from the atmospheric water chamber sits in the upside down cap on the soil surface and acts as a "rain" collector.

Groundwater (Bottle A) filled with 500 mL Groundwater. This may need to be recharged.

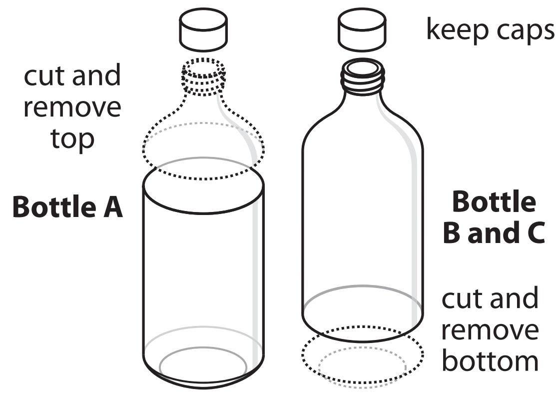


Fig. 20

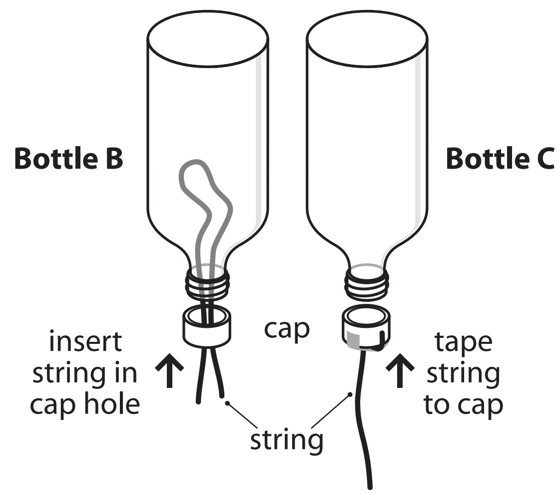


Fig. 21

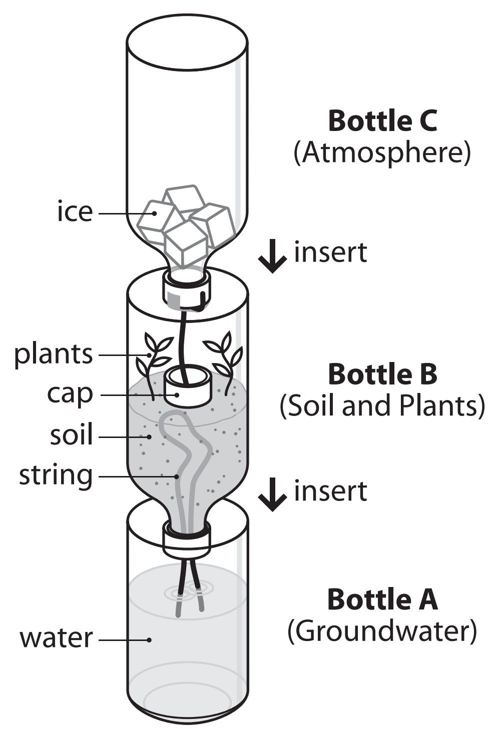


Fig. 22

ACTIVITY:

1. Have students work in groups. Each group builds a model water cycle.
2. Each student has a journal that begins with a drawing of their water cycle model. They can predict what will happen within the model.
3. It will take a few weeks for the seeds to germinate and become an active part of the water cycle. Students should be keeping their journal up to date with any observation, insights or questions.
4. When the seeds have grown, place the ice in the atmospheric chamber (Bottle C). Students should write about what this represents in terms of the Rocky Mountains.
5. Students make regular observation over the next few days. Replace the ice daily. They should be looking for signs of evaporation, transpiration, condensation and precipitation.
6. As a final journal entry, have students predict how this water cycle will change over time if the predictions of global warming come true?
7. Using the notes they have made in their journal, students write a summary of what they have learned about their water cycle using RAFTS:

- Role – whose point of view are you writing from? (self, water droplet, scientist, reporter, cloud…)
- Audience – who are you writing for? (self, classmate, politician, animal…)
- Format – what form will the writing take? (diary, cartoon, letter, code…)
- Topic – what are you writing about ? (the water cycle in this case)
- So what – what is the purpose of your writing? (justify, ask, persuade, complain, argue, warn…

They must include the words water cycle, evaporation, transpiration, condensation and precipitation correctly in their creation.

Extensions:

- Develop a scientific investigation using the water cycle model. What variables could be changed to answer a question?
- Create a play using what you have learned from your water cycle as the basis for your dialogue.
- How might you improve on this model? Suggest possible problems and ways that it could better represent the actual processes involved in the Earth's water cycle.

The Hidden Sea Panel Activities

BACKGROUND INFORMATION

What is groundwater?

Rain and snowmelt infiltrate the ground. Soil and rock act as giant sponges full of tiny pores and cracks that are usually less than millimetres in size. Below the water table, these holes are full of water. This is groundwater. Groundwater slowly travels through connected pores and cracks, just centimetres to hundreds of metres per year. Any rock or sediment that yields useful amounts of water is an aquifer. The volume of groundwater below us dwarfs the volume of water stored in glaciers, lakes, wetlands, and rivers.

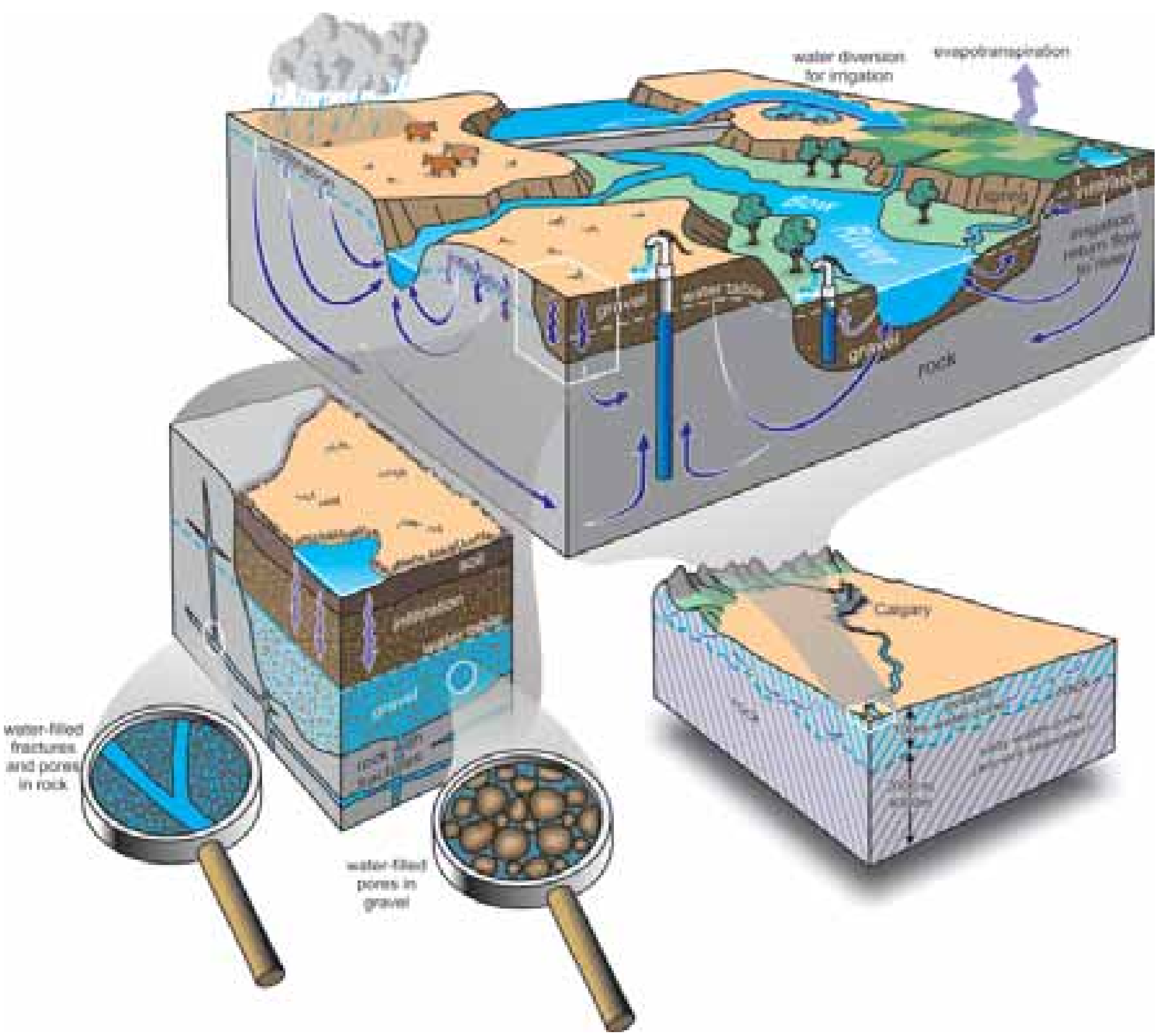


Fig. 23

Groundwater feeds the river

Groundwater and surface water are one connected water system. Water wells intercept groundwater that may be on its way to springs that feed streams and rivers.

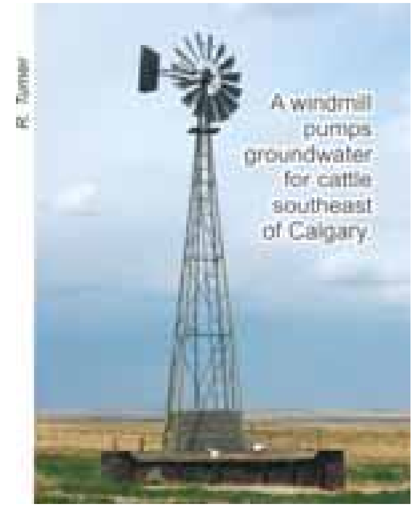


Fig. 24

Shallow groundwater: the precious drinkable part

In southern Alberta, oil and gas drilling has shown that groundwater is found to depths of four kilometres or more. However, most of this groundwater is very salty. Only shallow groundwater is potable or fit to drink.

Fig. 25 – A hand pump provides groundwater for drinking at Big Hill Springs Provincial Park near Cochrane.

Go With the Flow

Subject:
Science

Time:
one science period

Objectives:
- Model groundwater as well as the movement of a contaminant through an aquifer to the "river"

Materials: (per group of students)
- One 1.89 L rectangular plastic bottle from cranberry cocktail (COOP or Safeway)
- ½ ice cream pail of fine gravel (¼ to 1/8 inch pieces)-use white aquarium gravel if doing as a demonstration
- nylon stocking
- rubber band
- water
- blue food coloring
- clear plastic or glass jar/beaker/glass
- cocoa (about ¼ tsp)
- clear 2L pop bottle
- film canister with holes punched in bottom (translucent is best)

Procedure:
1. Cut away one of the narrow sides of the bottle.
2. Fill the bottle 2/3 full of gravel—so that gravel completely covers the mouth of the bottle. This creates your aquifer. Put the nylon over the neck of the bottle using the elastic to hold it in place. Screw the bottle cap over top of the nylon.

Fig. 26 – Go with the Flow Step 1

Fig. 27 – Go with the Flow Step 2

a. Groundwater demo

1. Pour the coloured water into the container and fill it until it is half way up the mouth of the bottle. This setup demonstrates the **groundwater** in the aquifer and the **water table**

   The groundwater model represents a cross-section of ground with gravelly soil underfoot. The nylon/rubber band represents the root structure on the bank of the river which prevents the gravelly soil from flowing freely into the "river" (clear container for catching water flowing from model). Discuss groundwater movement – does it flow or remain static?

2. To demonstrate the flow of groundwater, have a clear pop bottle full of the blue colored water and a clear container for catching the water ready. Remove the cap on the groundwater model, and simultaneously pour water from the pop bottle into the opposite end of the groundwater model. Collect the groundwater flowing through the model in a clear container.

Fig. 28 – Go with the Flow, groundwater demo Step 1

Fig. 29 – Go with the Flow, groundwater flow Step 2

Further Discussion:

1. What is the direction of groundwater flow? What direction do rivers flow?

2. Trace the flow of the Bow River until it empties into a large body of water. What is its primary direction of flow? Where does it end up? Can you find any rivers in Canada that flow north? Where do they terminate?

Pollution Plumes!!

1. Now place the film canister (which has holes punched through the bottom) on top of the gravel bed at the far end from the mouth of the bottle, and close to the front side of the model. This represents a tank or any container from which a contaminant may leak onto the surface of the ground. With the lid screwed on the plastic groundwater model, fill the film canister with the cocoa water "contaminant". This could represent excess fertilizer, sewage from cattle, leakage from an oil storage tank, etc. Allow the canister to empty into the aquifer, watching the contaminant plume form.
2. Demonstrate the movement of this plume by carrying out the same procedure as was used for the groundwater flow.
3. Collect the water in the plastic container, and then compare to the water entering the groundwater model.

Extension:

1. Examine the Bow River watershed and list the types of contaminant plumes that might enter the groundwater system.
2. In recent years water quality has been a concern in the Bragg Creek vicinity. Speculate on probable causes. Research has been carried out by environmental science students at the University of Calgary (U of C) Faculty of Science, Environmental Science, 4th Year Class Projects. This information can be accessed through the U of C website - Faculty of Science, Environmental Science, 4th Year Class Projects http://www.fp.ucalgary.ca/ENSC/research_projects.htm .
3. Gravel was used to simulate the underground "soil" in this model. Make a prediction about using different materials for the soil in the model – for example clay, or sand. Design and carryout an activity to detect differences in groundwater movement as well as contaminant plume movement in different types of "soil".

Fig. 30 – Go with the Flow, pollution plume Step 1

Fig. 31 – Go with the Flow, pollution plume Step 2

Before After

Fig. 32 – Go with the Flow, pollution plume Step 3

Please Don't Pass the Salt

Subjects:
Science, Social Studies

Time:
Model – 30 minutes of teacher time outside of classroom,
Activity – 1 class period

Objectives:
Alberta has a virtual ancient sea of water sitting underground but it is too salty to be potable. Students will learn about one technique —desalinization—which is already being used in certain arid regions to convert sea water to potable water, but it is a very expensive and energy intensive process. After seeing what is involved in removing salt from water, and thinking about the prohibitive costs involved, students should appreciate the importance of conserving the wonderfully fresh water we already have at our disposal and be motivated to conserve it for the future.

Materials:
- 1 – 1000 mL Erlenmeyer flask
- 1 – 500 mL beaker
- 36" Retort stand
- 1 – Ring clamp
- 1 – 3-finger clamp
- 2 – support clamps
- 1.5 m of ¼" plastic tubing (available at hardware or pet stores). One metre of glass tubing bent at right angles is an alternative to plastic but it must be bent, is very fragile and cannot be adjusted to fit as easily as plastic. One small piece (5 cm) of tubing is cut off to be used as a pressure release valve)
- Rubber stopper with a diameter matching the flask, with two ¼" holes
- 15 mL (1 Tb) of salt
- 500 mL (2 cups) of water
- Ice (bag since you will need to replace it several times during this process)
- Aluminum pan large enough to hold ice (cake pan size works well)
- Aluminum foil (quadruple thickness 15 cm x 15 cm) or aluminum lid from the aluminum pan
- Weights for top of beaker – metal washers work well
- Masking tape
- Heat source – alcohol lamp, Bunsen burner, hot plate
- Tongs or oven mitts for handling hot materials

PROCEDURE

Prompt:
Students may be surprised at just how much salt water can hold. Have two 1-L beakers. Fill one with 1 L of warm distilled water. In the other, have about 250 mL (1 cup) of salt. Take predictions about how much of the salt can be dissolved in the water. Begin adding the salt, spoon by spoon, stirring constantly as you do so. You will discover that all of the salt will dissolve (if the water is warm enough). Humans and other animals can detect very low levels of salt in their water and instinctively avoid it. This can lead into a discussion of how our water-rich planet seems like a place where nobody would ever be thirsty, but the majority of surface and groundwater is contaminated with high concentrations of salt.

Building the Desalinization Model:

1. Set up the desalinator as shown:

- Place 2 support clamps so that one will hold bottom of flask 5 cm from the flame and one will hold flask neck.
- Put three finger clamp in top support where the neck of the flask will be.
- Put ring clamp in bottom support clamp and place wire gauze on top of ring.
- Mix 15 mL (1 Tbsp) salt into 500 mL water in the flask. Swirl to dissolve salt and place rubber stopper on flask. Place flask on the support ring and hold top in place with three finger clamp.
- Fold a piece of aluminum foil into four thicknesses and place over top of beaker (or cut aluminum lid from disposable cake pan to fit). Make a hole just large enough for the plastic tube to fit through and reinforce the hole with several pieces of masking tape. Place beaker in bowl of ice. Place weights such as washers on top of foil to keep beaker from floating when ice starts to melt.
- Take the small piece of plastic tubing and put it through one of the holes in the stopper. Pinch the top off so that the opening is small but is large enough to allow steam pressure to be released.
- Bend the large piece of plastic tubing so that it goes through the other hole in the stopper and forms a smooth arc down to the beaker. The tubing should just pass through the stopper and foil, and not extend down into the flask or the beaker for more than a few mm.
- Place the beaker into a pan or bowl of ice.
- Turn on the heat source under the flask to begin the distillation process.

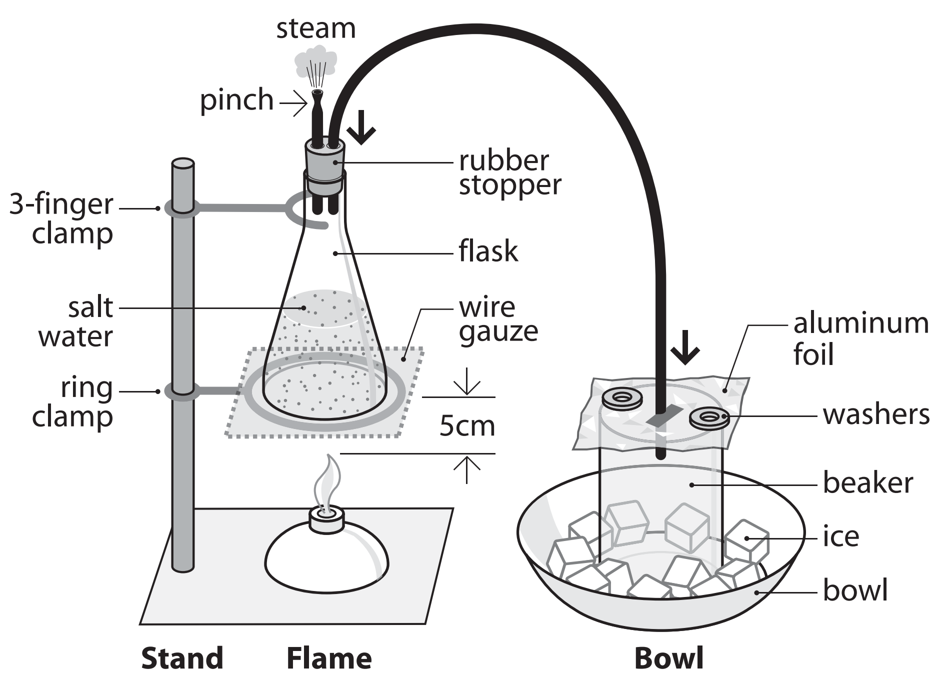


Fig. 33

ACTIVITY:

2. Discuss the distillation set-up with students. They should make inferences about what the function of each component is before you tell them. Basically, as the saltwater is heated to a boil, pure water vapour will rise into the plastic tube. As gas continues to fill the tube, some will reach the beaker, which is sitting in ice water. The cold temperature will cause the vapour to condense into water droplets that will collect in the beaker.

3. The distillation process will be time consuming. It is recommended to let the process continue on throughout the day once students have observed the evaporation and condensation phases for themselves. Stop the distillation when there is about 75 mL of saltwater solution left.

4. The next day, restart the distillation and get students to observe the saltwater solution remaining in the flask. They will notice that the salt is becoming very concentrated and is coming out of solution. It is important to carefully observe the flask at this point because you don't want concentrated salt water to reach the plastic intake tube. The saltwater will tend to be fairly explosive due to the viscosity of the mixture when concentrated. Once you see the explosive bubbling, you should stop the distillation process to avoid salt contamination in the plastic intake tube.

5. Students now take over the investigation and answer the following questions:

   - Why did salt start coming out of solution near the end of the process?
   - What is the substance left in the flask?
   - How could you find out how much of the original salt remained in the flask? Students might suggest letting it dry, collecting and measuring it.
   - Do you have the same amount of pure water as you started out with? If not, why not? What is the ratio of potable water to salt water?
   - If this process were being used in large scale, industrial desalination facilities, evaluate their efficiency in terms of time, expense, energy input, environmental impact and safety.
   - What possible uses might there be for the salt waste product?
   - Create a graphic organizer that summarizes the desalinization process that was demonstrated.

Extensions:

- Design and build a prototype of an alternative desalinization system based on what you have learned.
- Research to find out an estimate for the amount of saltwater in Alberta's underground aquifers. Based on this, and the proportion of potable water to salt water from the activity, calculate the amount of potable water reserves in our province from this currently unusable source.
- Research alternate desalinization processes (reverse osmosis, ultra-filtration and others) and establish criteria by which to compare/rank them.

Climate Change: What is the Future For Our Water? Panel Activities

BACKGROUND INFORMATION

Climate change: what is the future for our water?

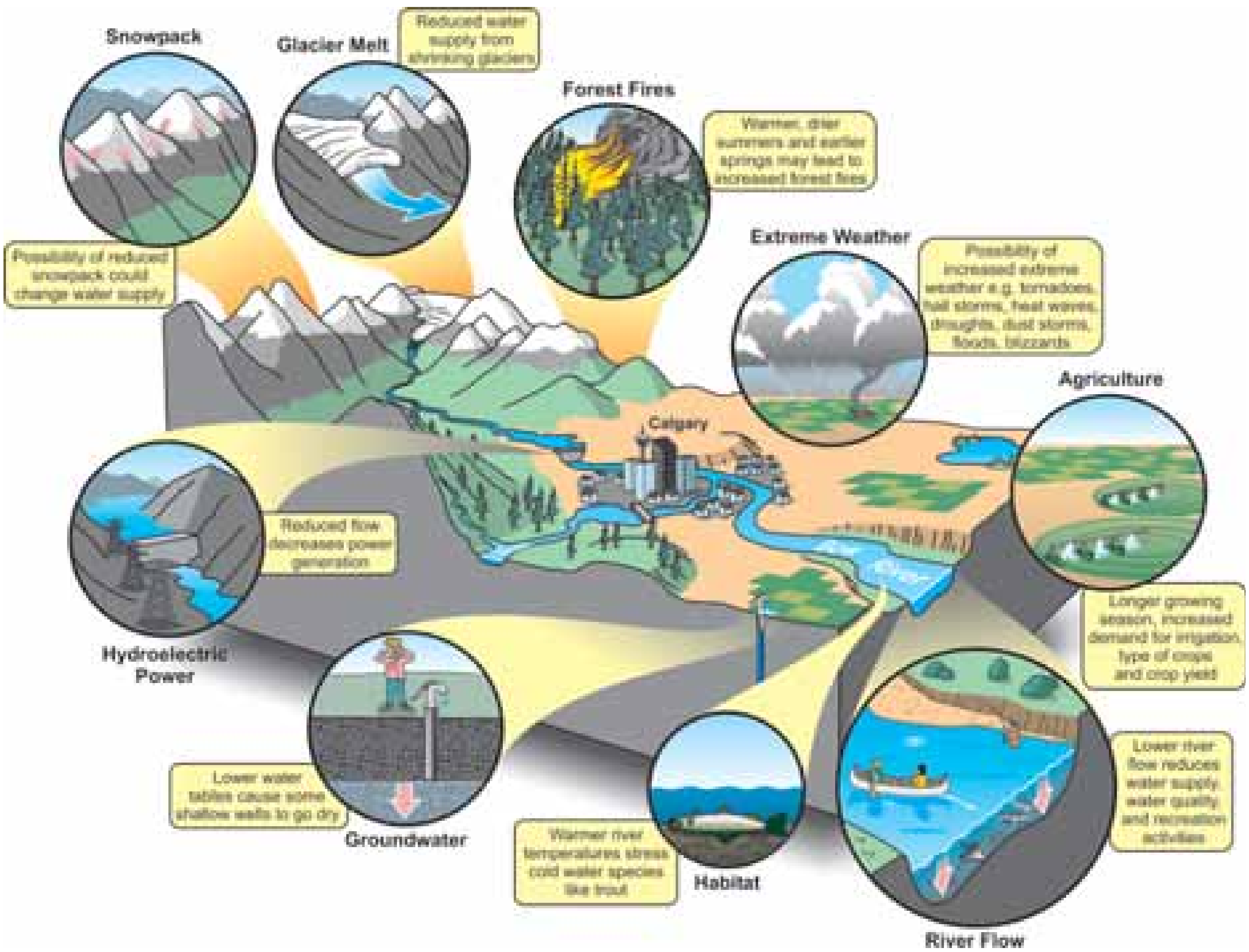


Fig. 34

This topic should be taught using an additional poster called **The Winds of Change: Climate Change in the Prairie Provinces** (GSC, 2001). This poster is an invaluable resource for teaching about climate change in Alberta. The poster is available from the Geological Survey of Canada, 3303 – 33rd St. NW in Calgary, Phone 403 292-7030. Visit their educational website at www.nrcan.gc.ca/gsc/education_e.html.

Where Have All the Flow-ers Gone?

Subjects:

Science, Social Studies, Math. (mini interdisciplinary inquiry project)

Time:

3 class periods

Objectives:

The city of Calgary is growing and our climate is warming up (perhaps there is a correlation there). This is good news for sun worshipers but bad news for the Bow River and its sustainability. In this activity, students will analyze data and interpret patterns in order to predict the availability of water for future generations. Based on their conclusions, they generate a list of recommendations.

Materials:

- Graphic data – enough copies for each group
- Summary sheets – enough copies for each group
- Bow River Basin Waterscape and The Winds of Change: Climate Change in the Prairie Provinces posters
- 2 L lemonade and cups (optional for prompt)

Note:

The graphic data and background information were used with generous permission from Zhuoheng Chen, Stephen Grasby and Kirk Osadetz of the Geological Survey of Canada from their paper, Historical Climate and Stream Flow Trends and Future Water Demand Analysis in the Calgary Region, Canada (in press).

PROCEDURE

Prompt:

Imagine that we all needed lemonade to survive. We need at least 42 mL per day to stay alive. Bring in a 2L bottle of lemonade and enough cups for everyone in class. Start out by asking how much each person will get from the bottle (2000÷25 = 80 mL per student). Have the cups marked with a line showing the 80 mL level. Pass out a cup to each student. But wait, we are going to travel 10 years into the future for just a few minutes. We now have 35 people in class because of increasing population. How much will each person get from the bottle (2000÷35 = 57 mL)? Everyone is still alive. Students can estimate where this line will be on their cups. Because of global warming, it will be hotter 10 years from now so 500 mL of our lemonade just evaporated. Each student will now have 1500÷35 = 43 mL. We are not happy with half of the lemonade we started with but we are alive. Because it is hotter, some people decide they need to drink more so 10 students drink 50 mL which is more than their share. How much does that leave for the rest of us to share? (1000 – 25 = 40 mL per person). A few of us just died! Could this scenario actually happen with real water in real life? Let them think about that as you give each of them their lemonade and introduce the activity.

ACTIVITY:

Class #1

1. Give students a brief background of how Calgary's water supply is directly affected by climate change. Do this by referring to the Waterscape and Climate change posters. This could be done by giving groups of students relevant panels from the posters. It will be their job to share the information with other groups by summarizing the main points, discussing their significance to Calgary and giving examples of how the information applies to a real life scenario here in Alberta.

2. Have a brainstorming session where students predict what factors will be affecting the sustainability of the Bow River water over the next 50 years. The list will probably include a number of factors which could be summarized under two distinct categories – population growth and climate change. This information can be put on the board for future reference.

Class #2

3. Give students graphic data from Calgary and the Bow. These graphs are from the most current research available and are from a paper looking at the relationship between historical climate and stream flow trends, compared with water consumption data from the past century in order to "establish a quantitative relationship among climate change, population growth and water demand" (Cheng et al., in press). Student graphs will include:

   - Graph A: annual average maximum temperature over the past 105 years which shows a 64 year cycle between warmer periods. The corresponding linear component for Tmax (maximum temperature) shows an increase of 0.45°C/100 years. Warm will be warmer.

   - Graph B: annual average minimum temperature over the past 105 years which shows a 30 year cycle between cooler periods. The corresponding linear component for Tmin (minimum temperature) shows an increase of 1.5°C/100 years. Cold won't be as cold.

   - Graph C: annual precipitation over the past 105 years which shows a 58 year cycle between dry periods. The corresponding linear component shows an increase of 27 mm/100 years. We will have more wet days but they won't be as wet (good news for the 2005 flood victims). The problem is that this will lead to more efficient evapotranspiration so there will be less water available to recharge the Bow (evaporation will far exceed precipitation).

   - Graph D: annual flow rate over the past 90 years which shows a 46 year cycle between low flow periods. The corresponding linear component shows a decrease of approximately 6%/100 years.

   - Graph E: daily water consumption per person relative to average temperature which shows a direct correlation (higher temp, more water consumed) but there is a dramatic increase when temperature rises above 10°C.

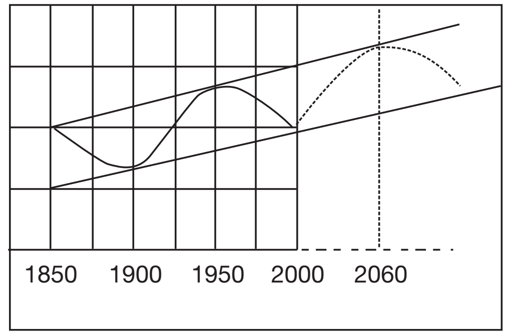
   - Graph F: annual water demand relative to population which shows increasing demand as the city grows. An interesting "blip" is observed in the 70's and 80's which indicates a virtual gluttony of water consumption. The sharp decline in the 90's is attributable to consumer education about water use and more efficient appliances. Per capita use is now down significantly through conservation efforts but there is room for improvement.

   - Graph G: annual population growth in Calgary (observed and predicted) for 200 years showing a continual rise over time. Present population is predicted to double by 2064.

4. Students will analyze each of the graphs and complete the questions on the data summary sheets. Model the process as a class with the first graphs (Annual maximum temperature and its linear component). Make overheads of the graphs and discuss axes, scales, and telling the "story" in words. The questions on the summary sheets are designed to ensure that students are thinking in the right direction. Once you have done the first graphs together, allow groups to work independently as you circulate among them and provide support as needed.

Instructions for Extrapolation—Keep in mind that this is REAL data and real data is not always "pretty". The measurements will be odd numbers.

- Extend the x-axis to the year 2050. Students should be able to do this using extrapolation of the current scale but you may need to help them for the first one or two. To check their extension to 2050 along the x-axis, approximate scale values will be 38 mm for graph A, 46 mm for graphs B and C, and 50 mm for graph D.
- Draw a vertical line at the year 2050.
- Extrapolate the low peak cycles by drawing a line from the peaks through to the year 2050.
- Extrapolate the high peak cycles by drawing a line from the peaks through to the year 2050.
- Determine distance between cycle peaks by measuring. Using this measurement, place the next one or two low/high cycle peaks on the extrapolated lines using dots. To check their work, the wavelength distance should be approximately 50 mm for graph A, 27 mm for graph B, 55 mm for graph C and 48 mm for graph D.
- Estimate the low/high peak cycle based on the location of the dots and draw the cycle in.
- Locate the position of the current year on the x-axis and draw in a vertical line.
- Students should now be able to answer the questions based on their knowledge of determining data from graphs.



Answer Key for Graphs (these will vary slightly depending on the accuracy of extrapolations)

Graph A: There is a cycle and it is 64 years long. We are just entering into a cooling trend for maximum temperatures. The maximum average temperature in the year 2050 should be 10.5° C.

Graph B: There is a cycle and it is 30 years long. We are nearing the lowest temperature portion of the cycle. The minimum average temperature in the year 2050 should be -1.7° C.

Graph C: There is a cycle and it is 60 years long. We are nearing the high peak of the precipitation cycle. The average precipitation for the year 2050 should be 470 mm.

Graph D: There is a cycle and it is 45 years long. We are currently at the maximum flow rate peak. The flow rate in the year 2050 should be 2900 m^3/s.

Graph E: As temperature increases, so does water consumption. It stays fairly level until temperatures rise above 10° C. This is probably due to the fact that it is summer, people are more active and thirsty, lawns are being watered, cars being washed, etc.

Graph F: The direction of the data plot tells you that as population increases, so does consumption. The blip in the 70's and 80's is probably due to more appliances, a care-free attitude about water consumption, larger houses with more plumbing, etc. The demand in the 90's was actually the lowest per capita in the last 70 years. This is probably due to environmental awareness and responsibility on the part of many consumers, more efficient appliances, more multi-family housing so less lawn, etc.

Graph G: The population increase is leveling but it is still rising. By the year 2060, the population will have at least doubled. 10^6 is 1 000 000 and 10^7 is 10 000 000 so students can figure out the scale and determine the approximate population at 2060 (around 2 300 000).

Class #3

5. Groups are now going to summarize their findings on the summary sheet where they discuss cycles and trends, along with potential consequences for sustainability. When done, have an open discussion about what has been discovered.

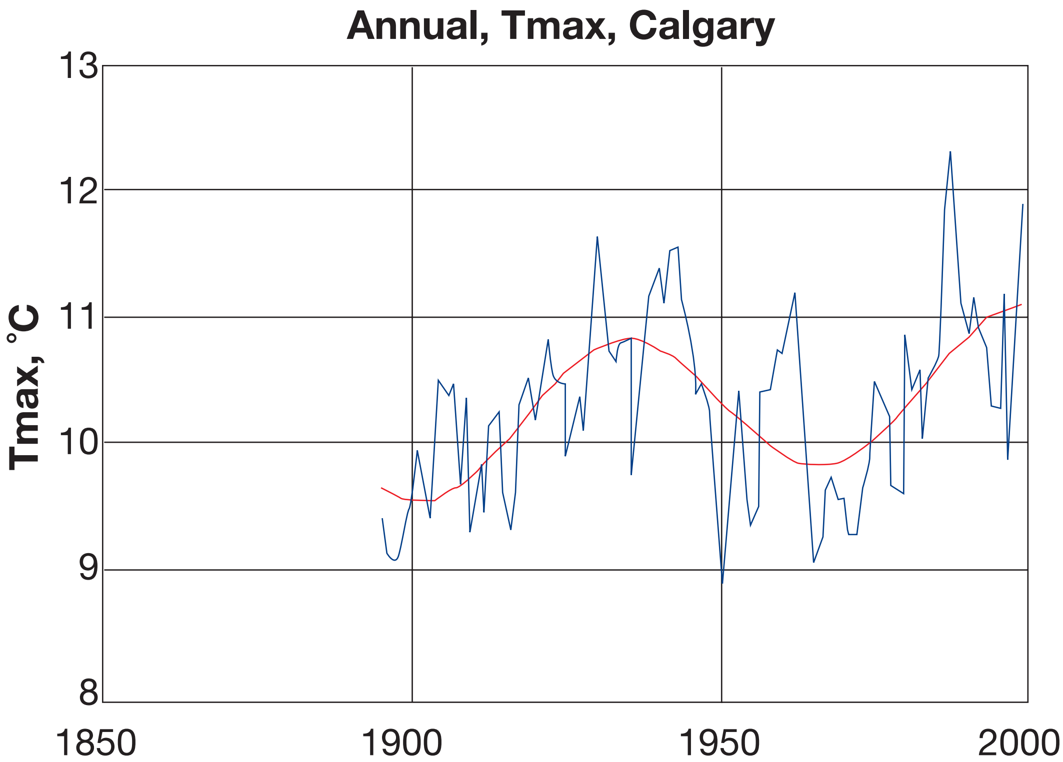
6. Make overheads of the last two graphs—historical and projected water demands in Calgary with different conservation scenarios. This data projects demand based on temperature and population values. Discuss their story as a group. Note that water production is considered equivalent to water use. Also note the current daily withdrawal limit of 1000 ML (megalitres or million litres) per day (license limit for the Municipality of Calgary). The 25% conservation scenario shows that by 2015, demand for water (particularly in the summer) will begin to exceed the daily withdrawal limit meaning there will have to be regular water rationing. With a 50% reduction in water use, our water supply should remain sustainable into the future. The exception will be periods of excess demand during prolonged hot and dry spells. Keep in mind that demand peaks in the summer when flow rate is at a minimum. Another factor to consider is the eventual disappearance of glacier water on which we depend during the height of summer to recharge the Bow River. Students compare their predictions with those of the final graphs.

7. Have students write a personal journal entry where they discuss their feelings about our future water consumption picture in Calgary, the reality that our population is going to have to drastically reduce consumption in order to maintain sustainable water resources, and personal choices that they can make to do their part in saving our water.

Extensions:

- Debate the causes of climate change from two perspectives – those who believe it is part of a natural planetary cycle and those who believe it is due to increased greenhouse gas emissions.
- Create a visual graphic organizer that will illustrate cause, effect and prevention based on what was learned from analyzing the graphs in this activity.
- Create an analogy for the relationship between climate change, population change and demand revealed by this activity.
- Create an awareness campaign within the school that will encourage everyone to become more conscientious about water conservation.

GRAPH A



Annual average maximum temperature over the past 105 years

1. Is there a cycle showing regular periods of warmer and cooler maximum temperatures?

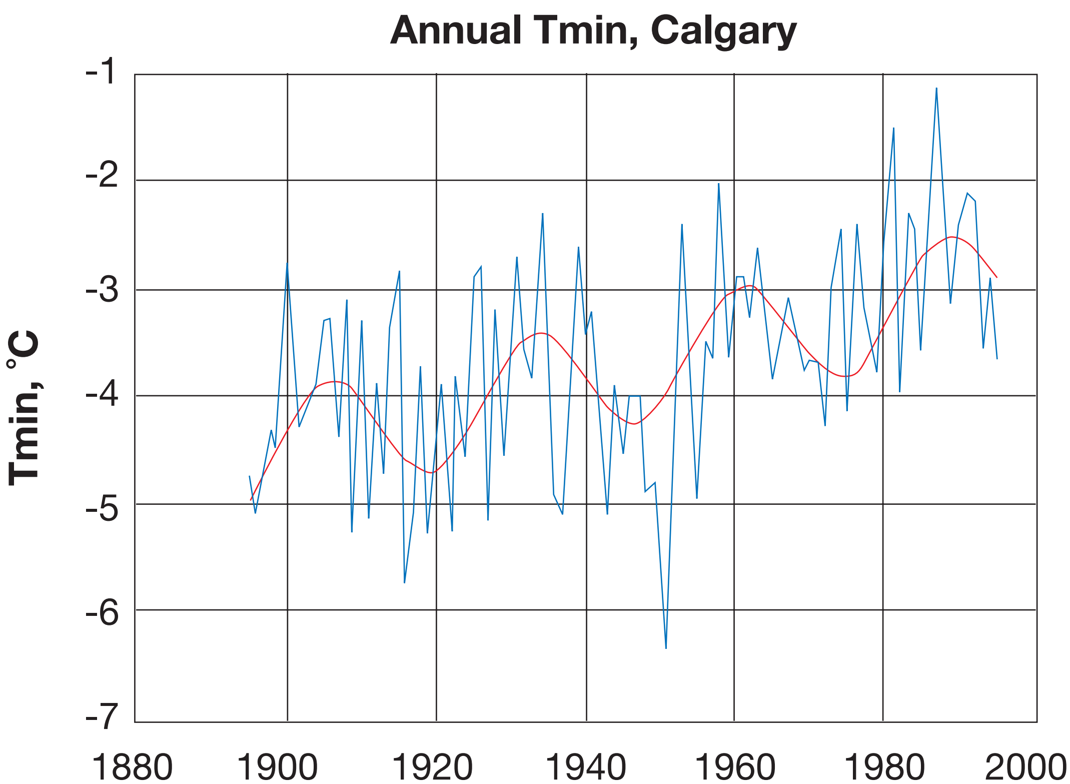
   ____

   How long is the cycle? ______________________________

   What part of the cycle are we in right now? ______________________

2. Using the linear component graph, extrapolate to the year 2050. Predict the average maximum temperature. ______________________________

GRAPH B



Annual average minimum temperature over the past 105 years

1. Is there a cycle showing regular periods of warmer and cooler minimum temperatures?

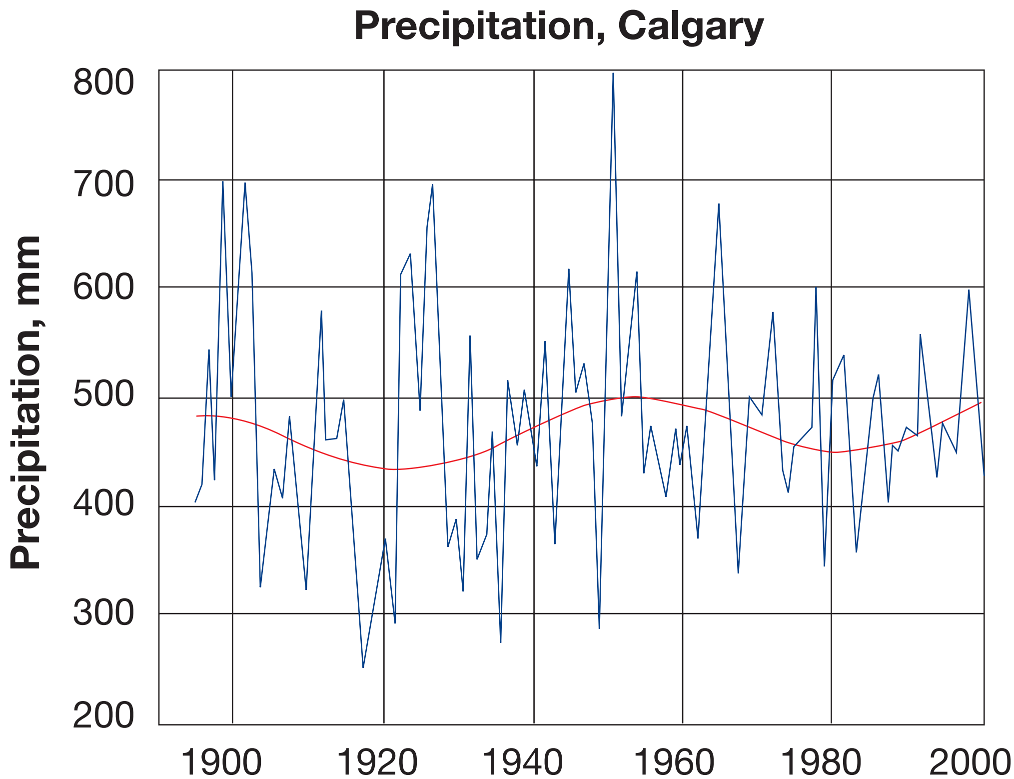
____

How long is the cycle? ______________________________

What part of the cycle are we in right now? ______________________________

2. Using the linear component graph, extrapolate to the year 2050. Predict the average minimum temperature. ______________________________

GRAPH C



Annual precipitation over the past 105 years

1. Is there a cycle showing regular periods of larger and smaller amounts of rainfall?

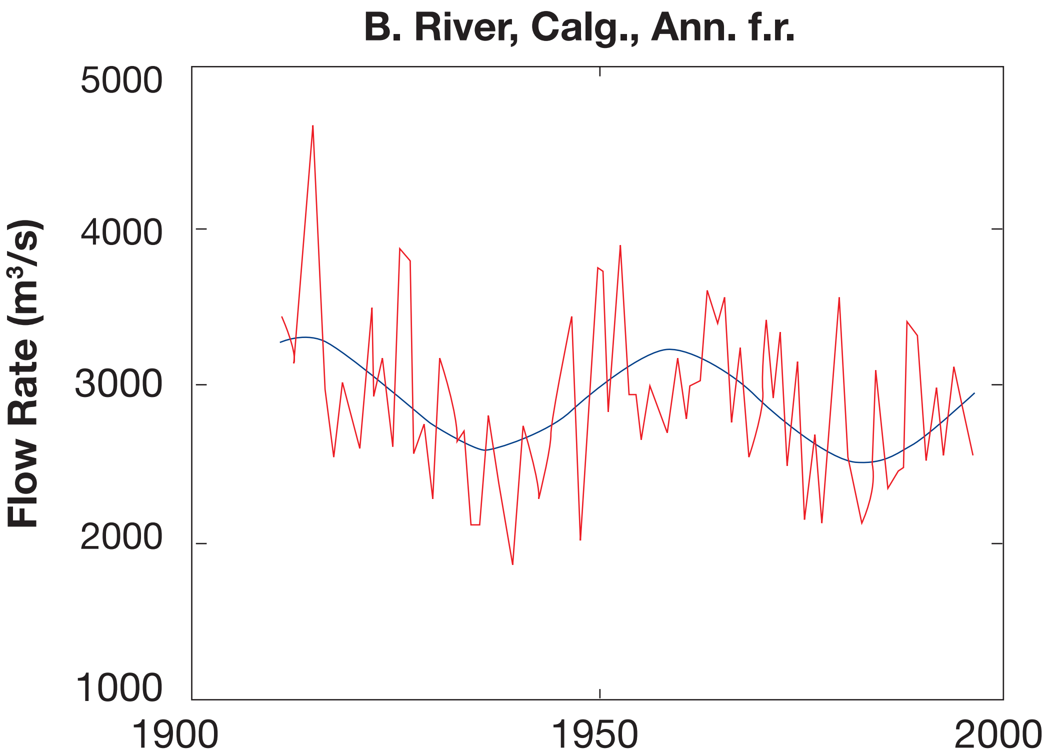
   ____

   How long is the cycle? ______________________________

   What part of the cycle are we in right now? ______________________________

2. Using the linear component graph, extrapolate to the year 2050. Predict the average annual precipitation. ______________________________

GRAPH D



Annual flow rate of the Bow River over the past 90 years

1. Is there a cycle showing regular periods of higher and lower Bow River flow rate?

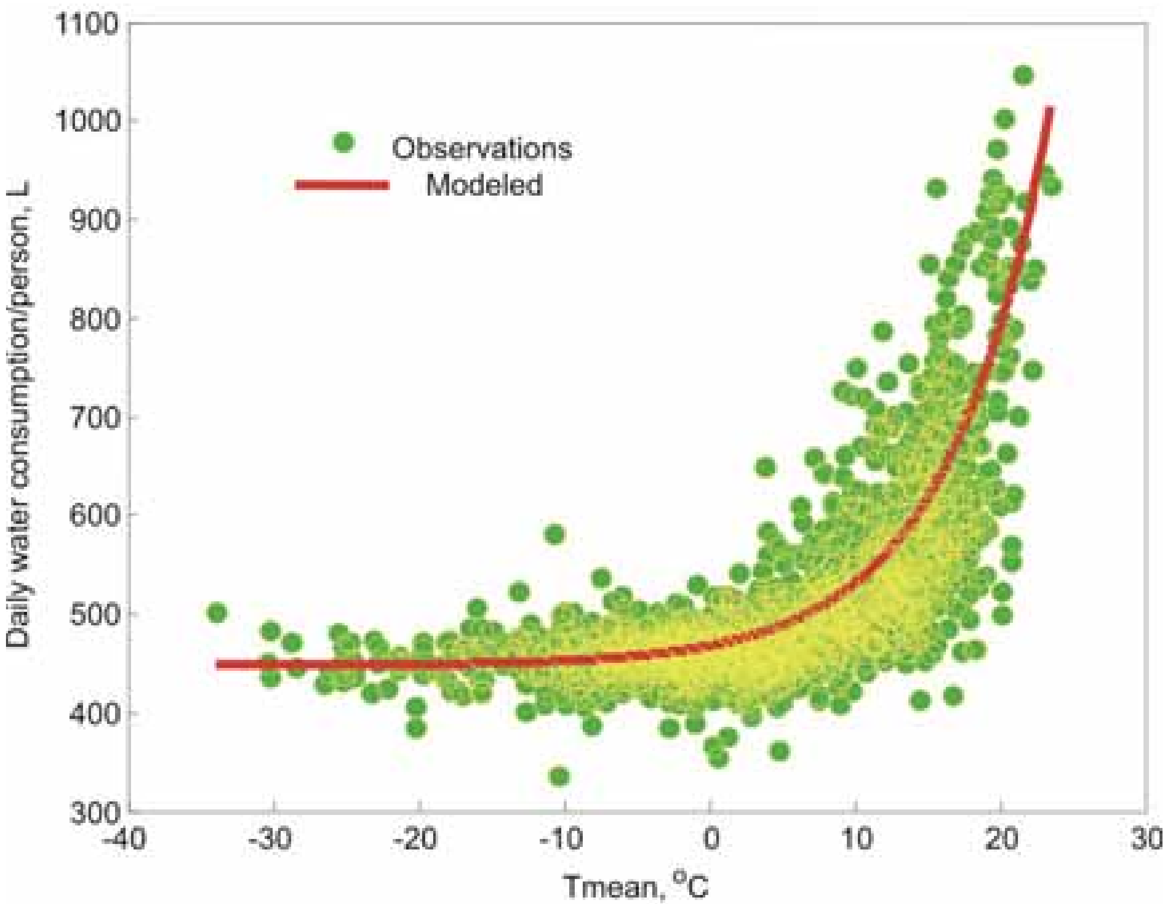
   ____

   How long is the cycle? ______________________________

   What part of the cycle are we in right now? ____________________

2. Using the linear component graph, extrapolate to the year 2050. Predict the average flow rate. __________________________________

GRAPH E



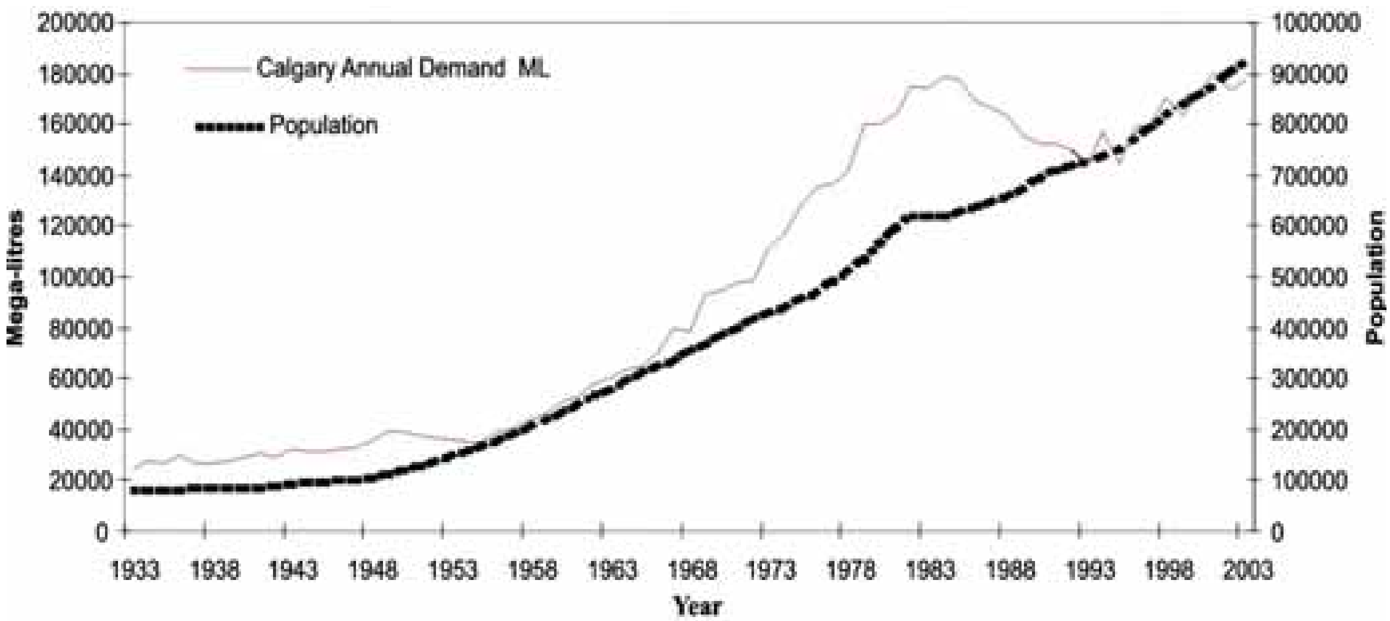
Daily water consumption per person relative to average temperature

1. What does the direction of the data plot tell you about the relationship between daily water consumption and temperature? ____

____

2. At what temperature does the slope of the data plot increase? ____________________
What can you infer from this slope change? ____________________________

GRAPH F



Annual water demand in Calgary relative to the population

1. What does the direction of the data plot tell you about the relationship between population and daily water consumption? ______________________________

____

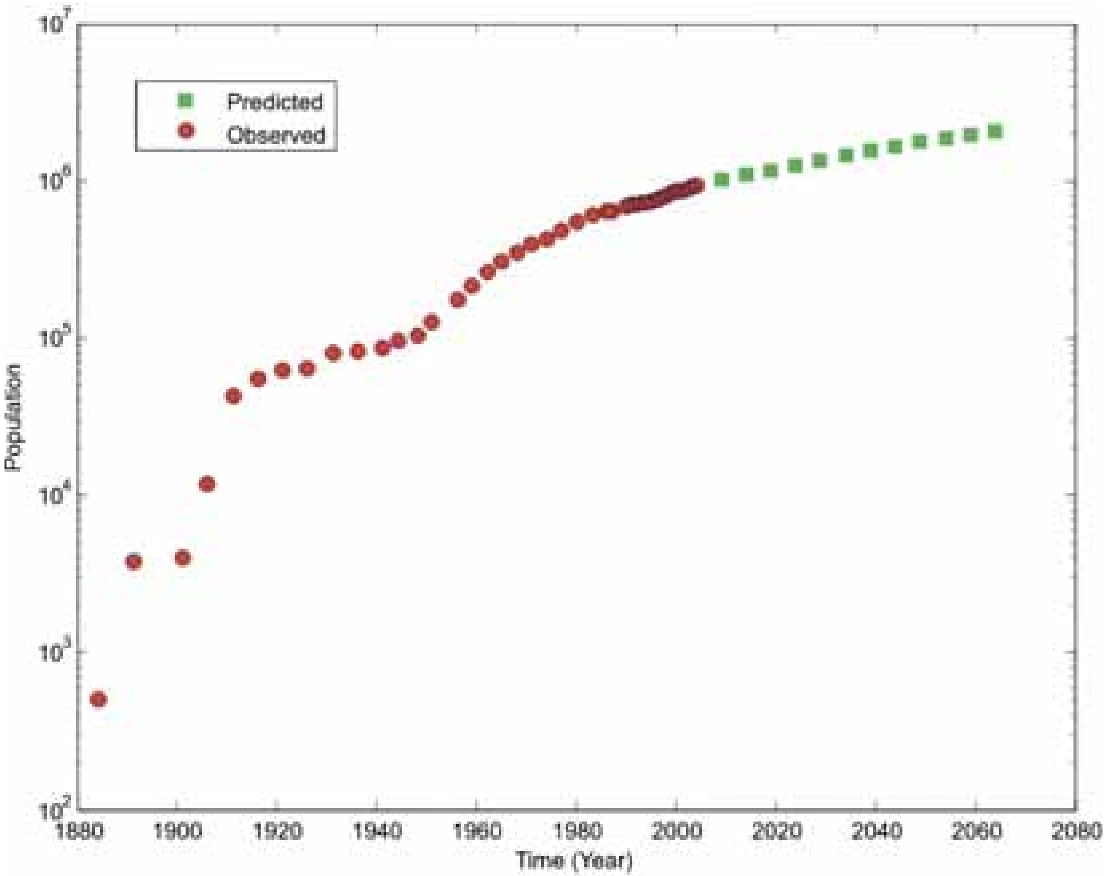
2. What can you infer from the "blip" in the 70s and 80s?.

____

3. Why might the demand have gone down in the 90s?

____

GRAPH G



Annual population growth in Calgary over a 200 year period

1. What does the general trend of the graph tell you about the population growth in the city?

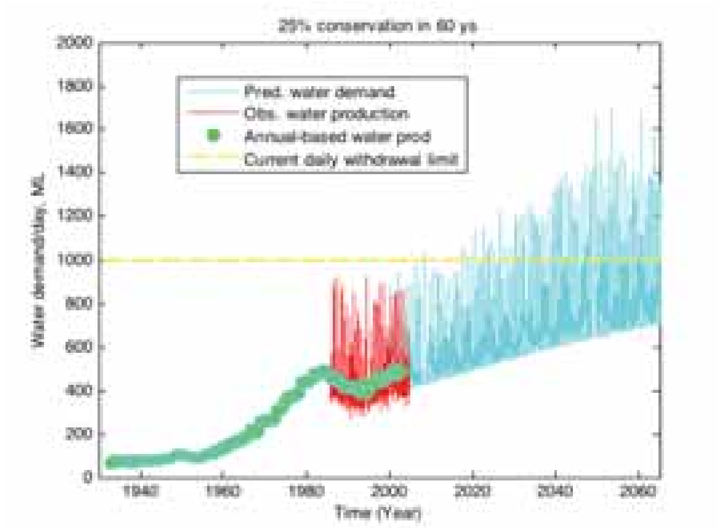
____

____

2. How many times greater will the population in 2060 be compared to current numbers?

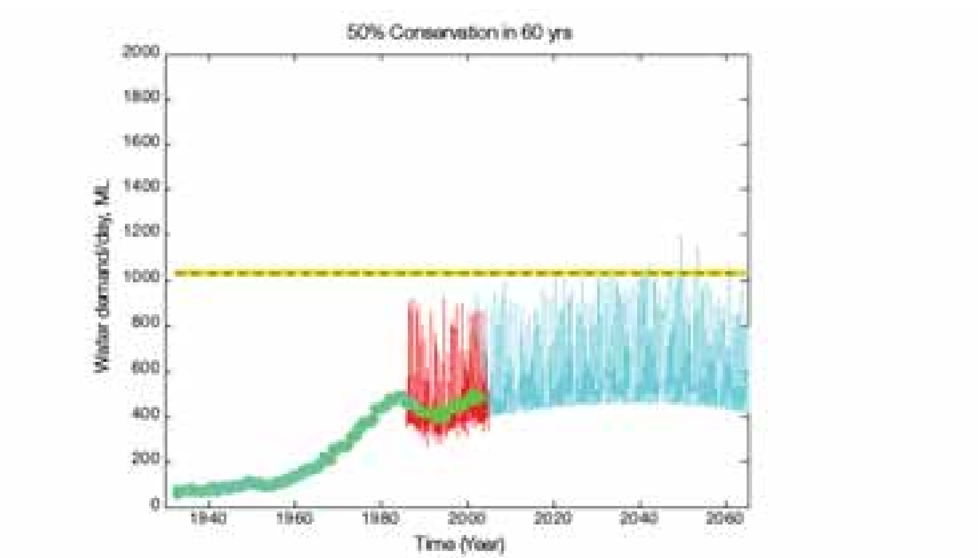
____

GRAPH H



Historical and projected water demands in Calgary
with 25% conservation over 60 years

GRAPH I



Historical and projected water demands in Calgary
with 50% conservation over 60 years

SUMMARY OF GRAPHIC ANALYSIS

Graph (Calgary data)	Summarize Data (trends, cycles, discrepancies, etc.)	Predicted consequences for sustainability of water from the Bow River
Average maximum temperature		
Average minimum temperature		
Annual precipitation		
Annual flow rate		
Daily water consumption		
Annual demand		
Population growth		

Watershed Down

Subject:
Science

Time:
One half class period

Objectives:
To observe the effect of lowering the water table on shallow wells, and to consider both human and environmental influences affecting the level of the water table.

Materials:
- One plastic groundwater model, half to two-thirds filled with gravel
- One pump (from an old dispenser of soap etc), or a straw
- Blue food colouring
- Sink, bucket or large bowl to catch water in

Procedure:
1. Set up plastic groundwater model as used previously in Go with the Flow (p. 34).
2. Insert the pump or “well” into the aquifer (gravel within the bottle).
3. Pour blue coloured water into “aquifer” until above the bottom of the “well”.
4. Let water drain from aquifer without replenishing it by loosening the cap at the mouth of the bottle and having it drain into a sink or container.
5. Observe the level of water in the “well” as the water table drops.

Extension:
1. List natural and human activities that could cause a drop in the water table.
2. Do you see this decrease in the level of the water table as being serious only for those on wells or for all of the citizens in the watershed? Explain your answer.
3. Assume that you are in a position to make political decisions—would you suggest specific action if there was a 15 year record showing the water table dropping consistently year after year? Explain your response.

Fig. 35 – Watershed Down, water table

Sharing Our Waters Panel Activities

BACKGROUND INFORMATION

There are many ways we depend on the Bow River

There are many, many users of the Bow River water and all are dependent on this shared water supply. These many users—wildlife, industry, municipalities, hydropower, agriculture, and recreation—commonly have no other source of water. So, we must protect and share this water.

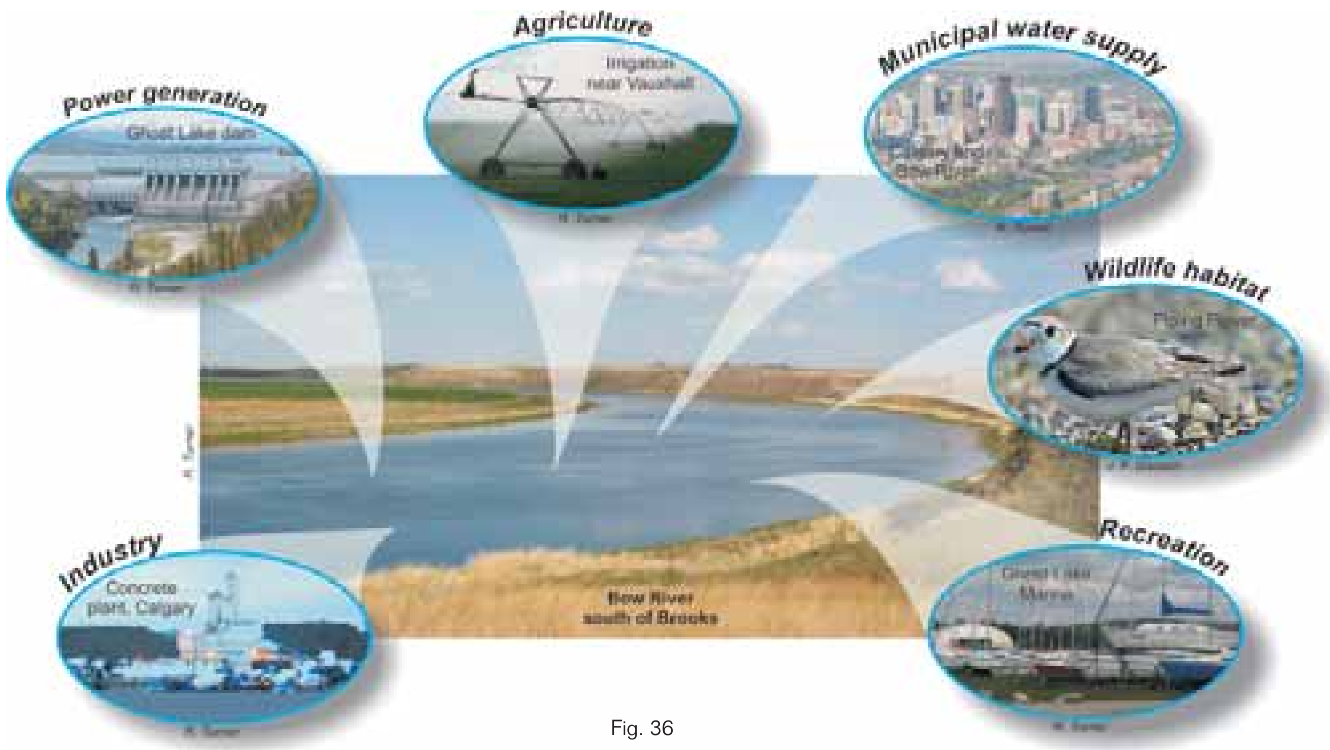


Fig. 36

Not all water use is the same!

Some water use occurs in the river, such as by wildlife and for fisheries, and recreation. Some water is withdrawn from the river, used, and returned (non-consumptive use). Municipalities return over 90% of the water they use as treated sewage. Some water is withdrawn from the river and not returned (consumptive use). In dry years, irrigation returns about 20% of what it withdraws. Most of the rest is used by plants, whereas some evaporates and a small amount sinks into the ground. Withdrawal of water from the river reduces river flow and can have an impact on wildlife habitat in and along the river.

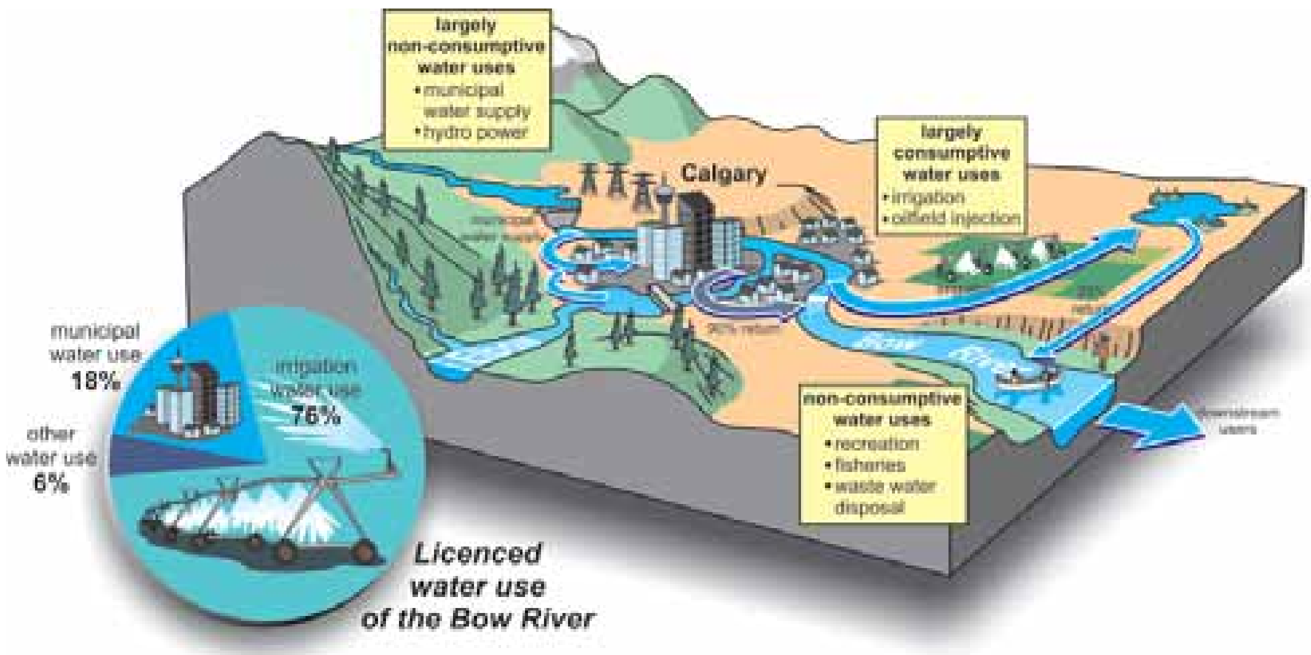


Fig. 37

Tasty Waste

Subjects:
Science

Time:
1 class

Objectives:
There are many different users depending on the Bow River as their only source of potable water. Even though users may be tens or hundreds of kilometres apart, their actions can have a direct impact on each other. In this activity, students gain an understanding of possible connections between groundwater and surface water (through wells, leaching, etc.), how pollution plumes can spread, and how contaminants that are hidden can suddenly appear in someone's drinking water!

Materials:
- Bag of miniature white marshmallows (20 per student)
- Ice cream – enough for class (individual, plastic ice cream cups which are available by the bag in any grocer are ideal for this activity since no one gets more than anyone else and there is less mess)
- Clear plastic drinking cups (enough for everyone in class)
- Straws – enough for 2 per student
- Masking tape
- Green food colouring
- Dropper
- Red sprinkles
- Plastic spoons (enough for everyone in class)

PROCEDURE

Prompt:
This activity is enough fun in itself that you don't really need a prompt to get students excited.

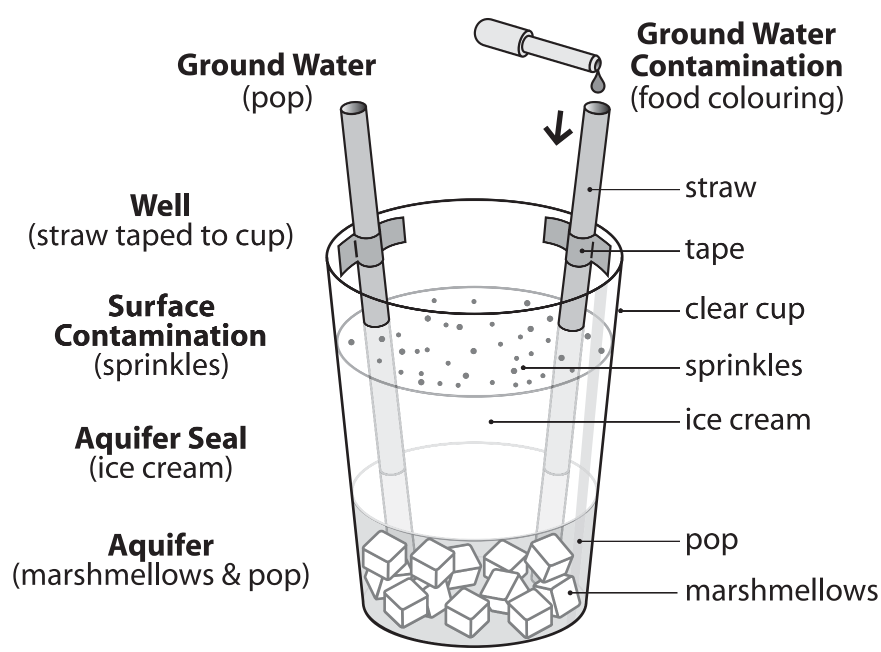


Fig. 38

ACTIVITY:

1. Have students brainstorm about how pollution plumes might move from groundwater to surface water or visa versa (groundwater flow, leaching, well contamination, etc.).

2. Tell students that they are going to create an edible aquifer to demonstrate how areas that are far apart can still contaminate each other.

3. Demonstrate the building and subsequent contamination of the aquifer using the following steps:

   - STEP A: Tape 2 straws to opposite insides of clear plastic cup. The bottom of the straw should be about 1 cm from the bottom of the cup.
   - Place marshmallows (20 is plenty) in bottom of cup. The marshmallows represent porous and permeable rock or sediment.
   - "Charge" the aquifer by adding just enough clear pop (water) to almost cover marshmallows. If you put in too much, the marshmallows may float; just push them back down with the spoon. Aquifers are charged from rainwater percolating down through overlying sediment.
   - **STEP B:** Take a spoon and remove the ice cream from its holder, carefully placing it in the cup on top of the marshmallows. It should be just about a perfect fit but you may have to push it down slightly with the spoon. This represents a less porous and permeable layer above the water table.
   - It is now time to start contaminating this pristine environment. To represent contamination on the surface (fertilizer, pesticide, herbicide, etc.) distribute red sprinkles on top of the ice cream.

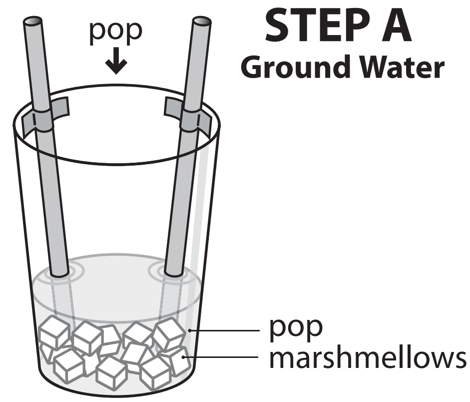


Fig. 39

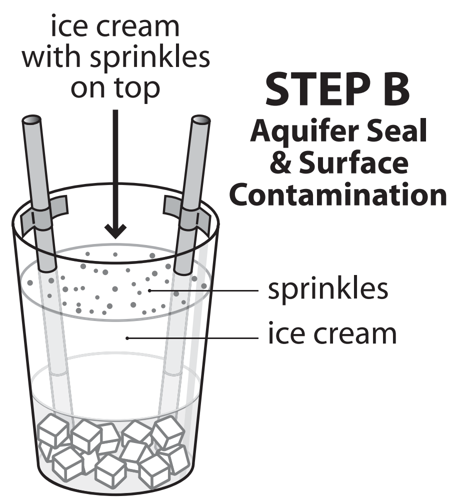


Fig. 40

Fig. 41

- **STEP C:** To represent contamination from an abandoned well, place ONE drop of green food colouring into the straw. It is recommended that this step be done by the teacher when students are making their models since food colouring can be an invitation to disaster in the wrong hands. GENTLY blow on the straw to move the contaminant down into the aquifer. Have students describe their observations of the aquifer.
  - To represent rain, sprinkle some pop over the surface of the model. Have students observe as red contaminant is leached from the surface and begins to percolate down through the soil toward the aquifer.
  - The farmer is going to need to get some water from his well. Have students predict what will happen when he sucks some liquid up through the well. Suck some of the pop up as students watch what happens to both the well contaminant and the surface contaminant.

4. Students are now ready to make their own models. Management suggestion – have packages made ahead of time for students (cup, 2 straws, 20 marshmallows, plastic spoon). Because the ice cream melts fairly quickly, you may want to do ½ of students at a time while others work on a related task.
5. Lead them through building the basic model. You may want to have three stations set up – one for adding rainwater (pop), one for adding ground contaminant (sprinkles) and one for adding oil contaminant (food colour). Two dependable students can deal with rain and surface contaminant stations while the teacher does the food colouring. This is also a great day to have a parent volunteer, if you can round one up.
6. Students go through the same steps as the demonstration, adding straws, marshmallows, pop, ice cream, sprinkles, more pop and food colouring. All along, they make visual observations. However, because this process needs to be done quickly in order for the ice cream not to melt, they do not make written observations until the end.
7. When done, students draw a before and after picture of their aquifer. They should label the aquifer, groundwater, water table, sediment and soil, sources of contaminant and paths of contaminant. They then infer reasons for contaminant paths and connect their observations to a real life situation where this might occur.

Extensions:

- Describe your own ecological footprint by keeping a diary of a typical day's water use (including how you use water to dispose of different kinds of waste material). For each entry, think about how this might affect someone else sharing your water and describe how you could lighten your footprint by changing your habits.
- A field trip to the Inglewood Wildlands is a wonderful experience for the class and an excellent example of how a site can be reclaimed after water has been polluted by an oil spill. Go to www.inglewoodwildlands.ca for information on how to take a class there.
- Design a way to remove or at least contain the contaminant from the polluted environment in the model aquifer. Of course, eating it will get rid of it but that is cheating.

What Goes In Must Come Out

Subject:

Science

Time:

one or two science periods

Key vocabulary:

water quality, pH, nitrate, phosphate, dissolved oxygen

Objectives:

- Identify pH, dissolved oxygen, phosphate and nitrate concentrations as important chemical factors for monitoring the health of river water.
- Research why these chemical factors are important to water quality
- Carry out techniques to measure each of these chemical factors
- Monitor the water quality of water from a variety of sources – tap water, river water, river water contaminated with fertilizer runoff
- Assess water quality by comparison to known acceptable standards

Materials:

A variety of materials work for this activity— some more expensive than others. The more expensive materials do a better job of measuring concentrations that are found in fresh water (i.e. Bow River water). However, the idea of measuring, monitoring, and assessing contamination can be obtained with less expensive materials, leading to less reliable results. Therefore two materials lists are presented —depending on your budget, and intent.

Note:

HACH Test kits available from two western Canadian distributors: ClearTech Industries Inc. (1-800-387-7503) and Anachemia Science – Edmonton (1-800-361-0209) or through the Prairie District Sales Manager of Boreal Laboratories – phone # 803-1719

Less Expensive Materials:

- Phosphate (0.0 – 5.0 mg/L) test kit for aquariums (75 tests for about $12.00)
- Nitrate (0.0 – 110.0 mg/L) test kit for aquariums (80 tests for about $12.00)
- Wards Dissolved Oxygen Snap Test (catalogue no. 21-9073) 30 tests for approximately $72.00 in kit including color comparators, refill set 30 tests for approx $45.00
- pH paper – a narrower range can be purchased from Wards catalogue no. 15-3153 pH paper strips 5.0–9.0, pkg of 50 for approx $5.50. Alternately a range of 6.0–8.0 can be purchased from Boreal, catalogue number #6321400 on www.boreal.com (6 rolls plus dispenser $47.00)

More Expensive Materials – more reliable results

- HACH Orthophosphate Test Kit Model 225001 (0.0–1.0 mg/L, 0.0–50.0 mg/l) (100 tests for approximately $192.00 plus shipping)
- HACH Ammonia Nitrogen Test Kit Model 224100 (0.0–3.0 mg/L) (100 tests for approximately $ 82.00 plus shipping)

Note:

Probes for measuring dissolved Oxygen and pH are available — the Prairie District Sales Manager for Pasco/Boreal/Sargeant Welch and Ward Scientific contact number is: 803-1719. The website is www.boreal.com, and the catalogue numbers for the monitoring equipment are:

Pasport:

- Xplorer Datalogger – catalogue # 6050139 ($269)
- Dissolved oxygen probe- catalogue # 6050150 ($375)
- pH probe – catalogue # - 6050144 ($135) Calculator-Based Laboratory System (Vernier)
- CBL 2 –catalogue # 45684 ($375)
- Dissolved Oxygen Probe – catalogue # 4717807 ($405)
- pH probe – catalogue # 4717801 ($205)

Additional Background: U of C Environmental Science 4th Year Class Project(2004/2005) on "The fate of nutrients and pathogens in the Bow River with respect to Bonnybrook wastewater discharge: website: www.ucalgary.ca – go to faculty of science, then to environmental science, then to 4th Year Class Projects, then to 2004-2005. This work provides some values recently measured on the Bow.

Water Quality Check:
Phosphates – not measured
Nitrate – 1.32 mg/L observed maximum
Ammonia – 0.55 mg/L observed maximum
Dissolved Oxygen 9.6 mg/L observed maximum
pH - 7.13 – 8.55

Conclusions:

- Wastewater effluent is the major contributor of nutrients and organic matter in the Bow River
- According to Alberta Environment and CCME guidelines, effluent impacts to the Bow River were not harmful to aquatic organisms on Oct 30 – 31, 2004

PROCEDURE:

Prompt:

Encourage students to question what is actually in water. Take two clear plastic glasses; surreptitiously put a tsp of bleach into one of the "glasses of water". (Don't let the students see!) Fill each of the glasses to the same level with water. Present the two apparently identical glasses to the students. Hold a food coloring container up and ask for predictions about what will happen if a few drops is added to each glass. Then drop food coloring into each glass and watch – tada!! – only the one without bleach stays colored!! Ask for inferences about why this happened.

ACTIVITY:

Obtain samples of the water to be tested: a comparison of water from the river, tap water, rain water, distilled water and water with some excess fertilizer will work well – the fertilizer water will show good reactions with the cheaper nitrate and phosphate test kits designed for aquariums. The pH of rain water is usually less than 6. This is because carbon dioxide gas from the atmosphere dissolves in the water to make a weak acid. Once in the ground or in the river, other factors control the pH that usually tend to increase it.

1. Follow the directions in the test kit for: **NB – Excellent instructions for use of the HACH kits as well as proper disposal of reagents after use is available on the riverwatch website: www.riverwatch.ab.ca under "How to Monitor". Also the directions for the dissolved oxygen snap test in the Wards kit are excellent, and simple to follow.**

Phosphate

Nitrate

Dissolved oxygen

pH

2. Compare the results of the tests with the following standards (approximations derived from combining values of CCME, AB Environment and Riverwatch):

Water Quality	Phosphate (mg/L)	Nitrate (mg/L) (aquarium test kit)	Ammonia Nitrogen (mg/L) HACH test kit	Dissolved Oxygen (mg/L)	pH
Excellent	0.01	< 10	< 1.0	9.5 – 11	
Good	0.01–0.05	10 to 40	1.0–3.0	5.5–9.5	6.5–8.5
Fair	0.05–0.1	40–100	3.0–5.0	4–5.5	8.5–9
Poor	0.1–10	> 100	> 5.0	0–4	<6.5 or >9

Extension:

1. Find out why nitrate, phosphate, dissolved oxygen and pH are important indicators of water quality. Present your findings creatively – a song, poem, skit, etc.

2. List activities along the Bow River that may cause an increase in nitrate and phosphate levels.

3. Imagine that you live in Calgary, and that you find out that water entering the Bow River just east of Cochrane is measured to have a phosphate concentration of 6.5 mg/L (this did happen in 1995). Suggest actions that might be taken by an individual or group of concerned citizens, Town of Cochrane, City of Calgary, or Alberta Environment.

4. Work in groups of at least two and have one person or small group choose to be either a rancher or a policy maker. Debate the introduction of this hypothetical regulation: Livestock must be fenced in so that a 50 metre boundary is maintained between all livestock and all tributaries into the Bow River, as well as the river itself. The other person (or small group) will debate the regulation from a different perspective.

5. In 1916, residents of Bassano complained about the effect of Calgary's sewage on the quality of their water. Research the changes in sewage treatment since that time and develop a time-line to show how that situation has been dealt with.

Urban Water Panel Activities

BACKGROUND INFORMATION

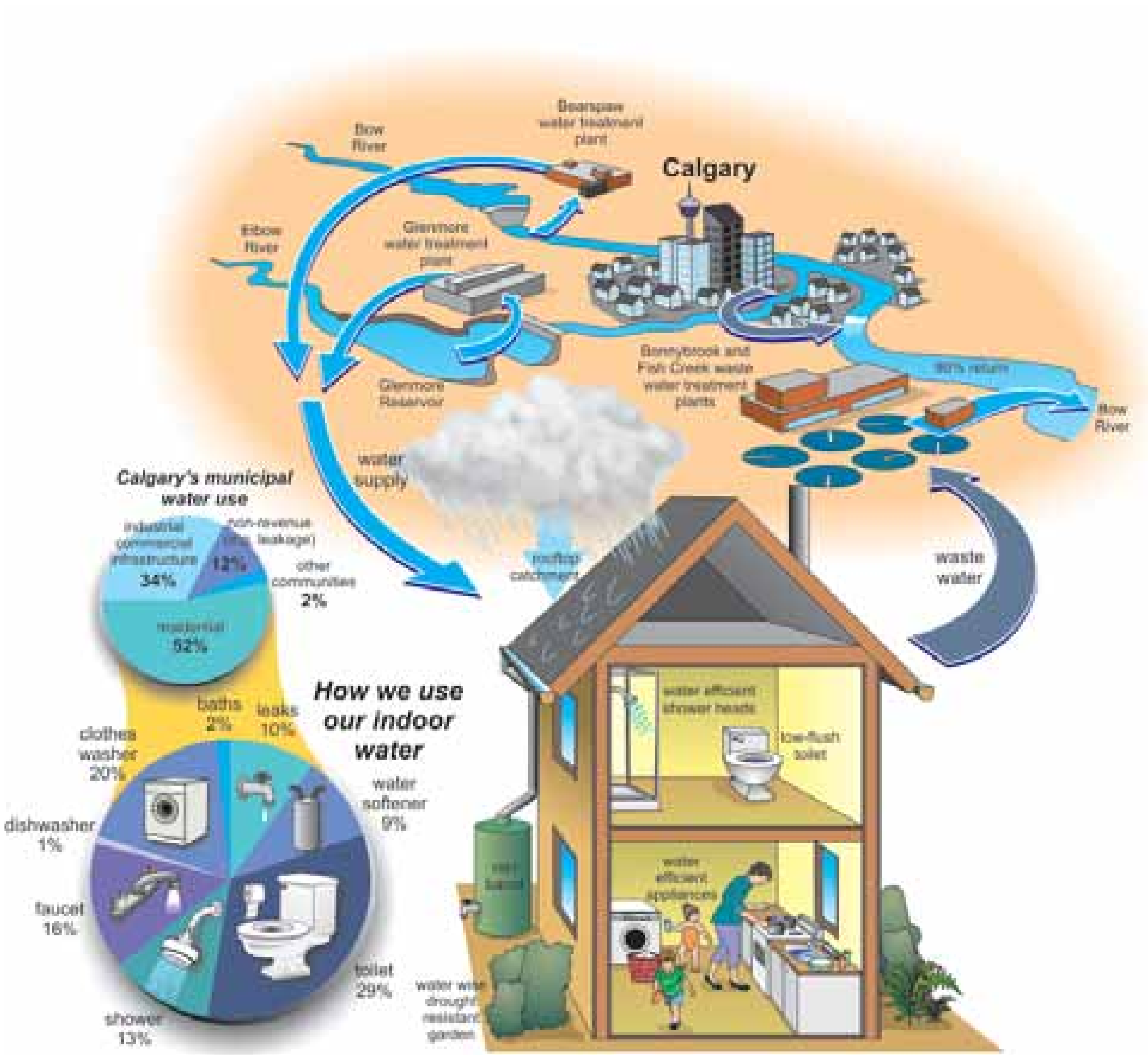


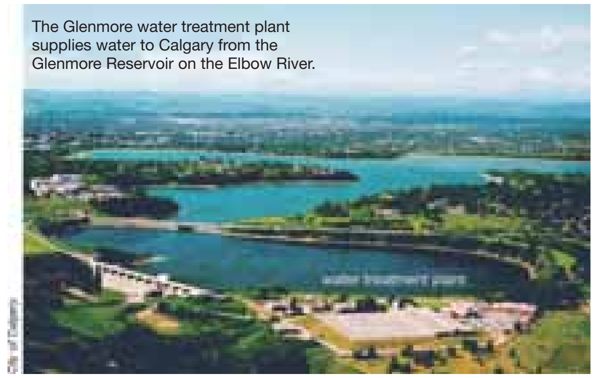
Fig. 42

Calgary: a big city on a small river

Calgary is a big, rapidly growing city on a relatively small river. The Bow River, a world class trout stream, has a limited capacity to assimilate waste water without reducing its water quality. Because of this, the standard of Calgary's wastewater treatment is among the very highest in Canada.

Much of Calgary's sewage is treated at the Bonnybrook wastewater treatment plant (foreground) before discharge into the Bow River

Fig. 43



The Glenmore water treatment plant supplies water to Calgary from the Glenmore Reservoir on the Elbow River.

Fig. 44

Bow River water enters our lives in many ways.

Experiments show that your body's water is completely replaced every four weeks.
If you live in the Bow River basin, you are largely made up of Bow River water. So, when you turn on the tap, drink a pop, or eat bread, locally-grown vegetables, or beef, think "Bow River."

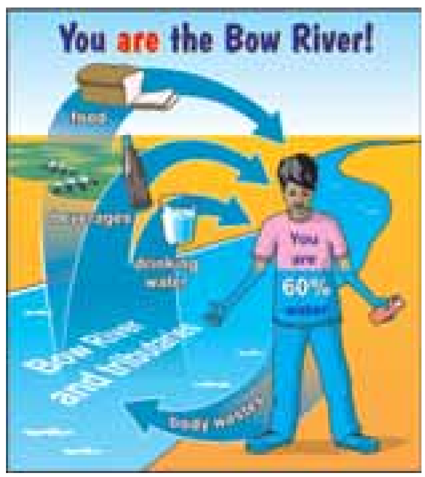


Fig. 45

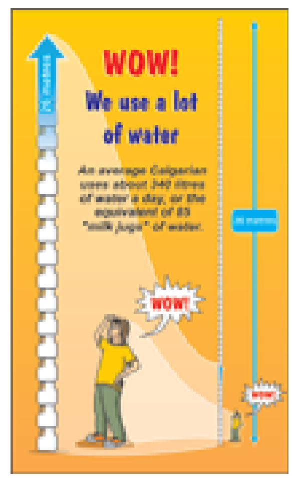


Fig. 46

Fig. 47

Take a Bow, Calgary

Subjects:
Science, Social Studies

Time:
1 class period

Objectives:
In this activity, students will become aware of the tremendous job the City of Calgary does to ensure that our city's waste water disposal system is an example for cities all over the world. They will also learn more about the tertiary and ultraviolet water treatment system used to clean wastewater before its return to the Bow River.

Materials:
- Copy of The National Sewage Report Card (Sierra Legal Defense Fund, 2004) at http://www.sierralegal.org/reports/sewage_report_card_III.pdf which rates 22 Canadian cities.
- From the Tap to the River: The City of Calgary Wastewater System (available from City of Calgary Waterworks – see resource section)
- Optional for prompt — Tap water (approximately 4 L), Pitcher, 2 brands of bottled water (2 L each), Dixie cups (enough for everyone in class). If you can find a very cheap source of cups (such as Wendy's catsup containers) then you can use 4 cups for each student.

PROCEDURE

Prompt:
Take four unlabelled water bottles. Fill one with Calgary tap water, one with tap water that has been left in an open container for several hours, allowing the chlorine to evaporate, and the other two with any of the bottled water brands currently on the market – lots to choose from. Make sure they are all at the same, cold temperature. Students will take turns doing the taste test. Students will be asked to rate the taste by ranking the bottles from 1 (best taste) to 4 (worst taste). When done, tally up the results to see which one is the winner. The water with the lowest score will be the victor. Lead the class in a discussion about bottled versus tap water. Everyone talks about the ills of tap water and how much better bottled water is but students need to ask themselves if they are just being taken in by the bottled water "spin doctors".

ACTIVITY:

1. Students are not the only ones getting grades. The National Sewage Report Card rates each major Canadian city according to its wastewater disposal practices. This report can be shared with students who should rightly take pride in the fact that Calgary was the only city to receive an A+ rating. That is something all of us can be very proud of. Discuss the following criteria used and why each one is considered to be an important evaluation consideration.

   - Type of treatment (primary, secondary, tertiary, ultraviolet) – Calgary uses both tertiary and ultraviolet. Ultraviolet disinfection is phasing out chlorine treatment because chlorine can damage the environment.
   - Raw sewage discharged – Calgary, none
   - Sewage overflows annually – Calgary, none
   - Toxicity testing – Calgary has some of the most stringent testing requirements in the world and they test on a regular basis.
   - Sludge disposal – Calgary treats sludge biologically and the leftover biosolids are trucked to farms for fertilizer.
   - Sewage-related charges – Calgary, none
   - Changes – Calgary has upgraded and added the UV treatment phase, new sewage treatment facility being built in south Calgary, $250,000,000 approved for further upgrades.

2. Compare Calgary's system with another Canadian city receiving a poor mark (e.g., Montreal with an F, Vancouver with a D, etc.)

3. Distribute and discuss From the Tap to the River which clearly illustrates Calgary's wastewater treatment procedures.

4. Your students are now going to "become one" with sewage treatment. Divide students into 10 groups. These groups will be:

   - Wastewater (raw influent)
   - Headworks – screens that remove large material from wastewater
   - Primary clarifiers – used for settling and skimming
   - Bioreactors – good bugs use sewage as nutrients
   - Secondary clarifiers – remove good bugs (that's gratitude for you)
   - Digesters – anaerobic decomposition of sewage
   - Disinfection UV – makes any remaining microorganisms sterile so they don't reproduce.
   - Treated effluent – water returns to the Bow River
   - Sludge – sent to Shepard lagoons to settle
   - CALGRO – takes final sludge product to farmer's fields

5. Each group is responsible for coming up with a way to act out their part of the treatment process. Give them about 10 minutes to find out about their job and create a way to represent the process.

6. When everyone is ready, the wastewater group will start the process off and student ingenuity does the rest.

7. Lead the class in a discussion about bottled versus tap water.

Environmental Costs of Bottled Water:

- Every year, 1.5 million tons of plastic are used to make bottled water. Toxic chemicals are released during the manufacturing and disposal of the plastic bottles.
- There are 90 billion litres of water bottled annually and the majority are shipped. The fuel used for transporting water contributes to acid rain and enhanced greenhouse effect.
- A tremendous amount of water is used in the manufacturing process. For every litre of bottled water produced, it is estimated that approximately 1000 litres of water are used. When you are talking about 90 billion litres of bottled water, this takes a very large bite (or gulp) out of our water resources.
- Drinking distilled water, which many bottled waters are, actually drains your body of minerals, whereas, tap water provides many essential minerals.

Economic Costs of Bottled Water:

- The bottled water industry is the fastest growing drink industry in the world despite the fact that in most countries, including Canada, tap water is as good or better than bottled water.
- There are more standards regulating tap water than bottled water in Canada.
- Many bottled water labels are actually tap water so the only difference is one comes from pipes and one comes from plastic.
- The average cost for 1 L of bottled water is 80¢. The cost for 1 L of tap water for residential customers in Calgary is just slightly over 1/10 of 1¢. In fact, it is less than 0.1¢ since that cost includes wastewater charges as well. Talk about a deal!
- If you really don't care for the taste of tap water, put some in an uncovered pitcher in the fridge for a few hours. It will be delightfully cold and the chlorine which offends some people's taste buds will have evaporated off.

Extensions:

- Write an editorial for the school newsletter where you inform people of the possible consequences of the choice to drink bottled water instead of tap water.
- Design a survey for the students in the school in order to collect data about awareness of the economic and environmental consequences associated with bottled water. From the data, make recommendations to the school administrators about the need to encourage the use of reusable bottles and tap water by students and teachers.

Water Use Challenge

Subjects:
Science, Math, Social Studies

Time:
1 class period (1 week observation)

Objectives:
- Identify how water is used in and out of the home.
- To develop personal awareness about water use and practical ways to conserve water.
- To develop a sense of personal responsibility towards water use.

Materials:
- Water Use Challenge handout (modified from the Water Works Activity Book by the City of Calgary Waterworks)
- large beaker
- pitcher with water
- watch with second-hand or timer

Procedure:

Prompt:
People use water each and every day, directly and indirectly without much thought. We take it for granted; when we want water, we simply turn on the tap and voila it appears, as if by magic. In the city of Calgary, a family of four might use 1000 litres of water each day. That is equal to over 250 milk jugs full of water or 250 litres (63 milk jugs) per person per day. Begin by asking students some questions to get them thinking and developing awareness about this precious resource. Ask the students to predict how much water they might use over the course of one day? One week? How is water used at home, both inside and outside? Rate these activities according to the relative amount of water used, for each activity, from the least to the greatest.

ACTIVITY:

(as a demo or in small groups):

1. Fill a pitcher with water. Have a large beaker available.
2. Measure how much water is poured from the pitcher into the large beaker in 5 seconds while pouring relatively quickly. Record the results.
3. Measure how much water is poured into a large beaker in 5 seconds while pouring slowly. Record the results.
4. Have students compare the relative amount of water poured.
5. Discuss with students how controlling the flow rate of water can help conserve water.
6. Next, introduce the survey as a way to help monitor water use at home. Have students use water as they normally would to have a better understanding of how much water is typically consumed.
7. Explain the survey to students. Have students record their observations on the provided Water Use Challenge handout over the course of a week.
8. Spend a few minutes daily comparing relative water use among students.
9. At the end of one week have students tally the total amount of water used and compare results with each other. Which activity occurred most often? Which activities used the most amount of water?
10. As a class, compile the student data into a class tally chart.
11. Have students create a bar graph showing the relative amount of water used by the various activities at home.
12. Discuss practical ways water can be conserved. The City of Calgary has some good resources available, including: Tap into Indoor Water Savings & Outdoor Gardening Tips (brochures).

Extensions:

- Have students follow-up with another week of water monitoring, but this time using water conservation strategies to see how much water they can save by simply changing a few habits, and if possible, fixing leaks.
- Have students investigate the use of water by people in other countries. Would people in drier climates use more or less water? Why? The internet would be a good place to start investigating this question, especially www.ec.gc.ca/water/images/manage/use which lists the average daily domestic water use (per capita) in a number of countries: USA 380 litres, Canada 335 litres, Italy 250 litres, Sweden 200 litres, France 150 litres, Israel 135 litres.

Name:________________________

Water Use Challenge

Water Activity	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total	Estimated water used per activity (Litres)	Total water used Total x Water used per activity) (Litres)
bath (regular size tub)	✔		✔		✔			3	90	3x90L=270L
bath (regular size tub)									90	
bath (large size Jacuzzi tub)									150	
washing machine: top loading (per load)									180	
washing machine: front loading (per load)									70	
cooking a meal									12	
dishwasher (per load)									40	
washing dishes by hand filling a basin									30	
water running from the tap (per minute)									11	
drink glass of water (let water run until cold)									20	
drink glass of water (from jug in fridge)									1	
wash hands with water running									20	
turning tap off while brushing your teeth									4	

Water Activity	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total	Estimated water used per activity (Litres)	Total water used Total x Water used per activity) (Litres)
running the tap while brushing your teeth									32	
shaving									8	
use garbage disposal (in sink)									11	
leaking faucet (per day)									25	
shower (regular showerhead, 5 minutes)									60	
shower (low flow showerhead, 5 minutes)									45	
flush toilet (older toilet)									20	
flush toilet (low flow toilet)									6	
water lawn (per hour)									950	
washing car									200	
Total weekly water use by household member (Litres)										

Irrigation: Watering the Prairies For Food Panel Activities

BACKGROUND INFORMATION

Transforming the prairie: dry grasslands to watered prairie

When European settlers first came to the prairie country of the Bow River basin, they found First Nations peoples living in a vast grassland with few lakes and streams. Early in the last century, irrigation districts were established to move Bow River water out onto the prairie. Through a system of canals and storage reservoirs, water was supplied to farmers. Over time, communities and industries also grew on the prairie, and the irrigation system supplied water for their needs.

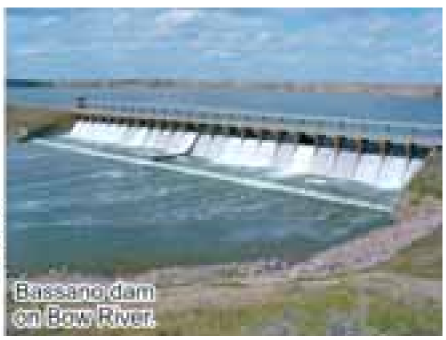

R. Turner
Bassano dam on Bow River.

Fig. 48

R. Turner
Irrigation canal south of Brooks.

Fig. 49


Ducks Unlimited
Water storage in wetland near Brooks.

Fig. 50


R. Turner
Irrigation spray near Vauxhall.

Fig. 51


R. Turner
A hay harvest north of Brooks.

Fig. 52

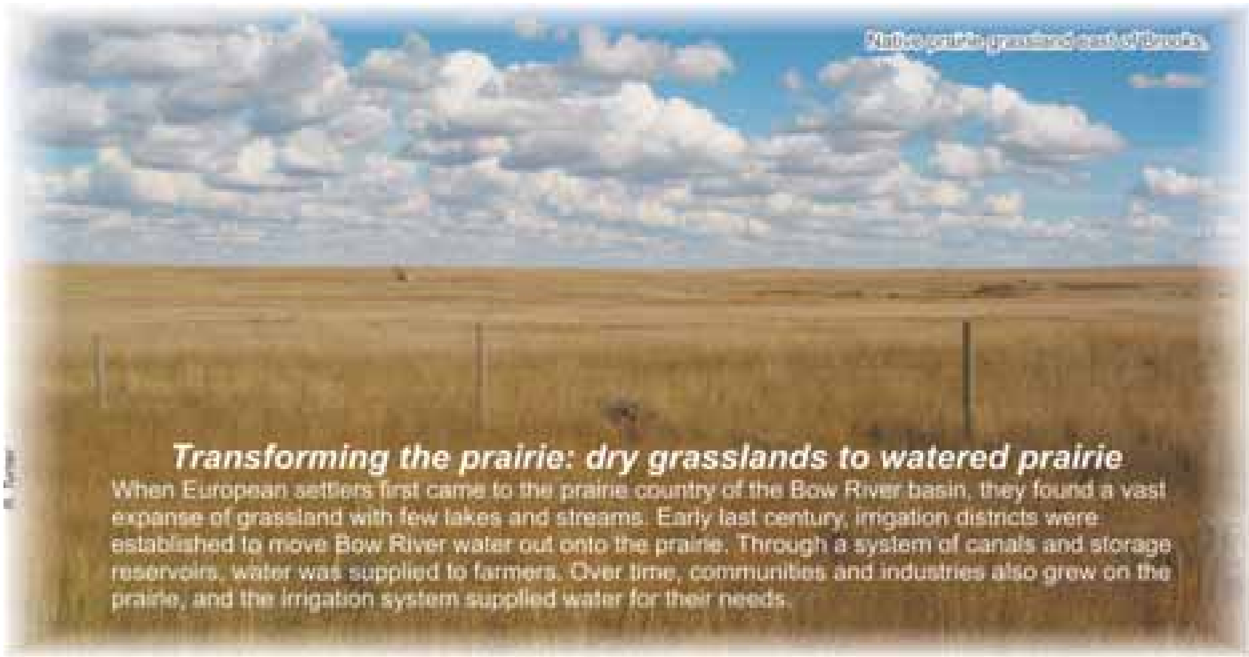


Fig. 53

How irrigation works

Irrigation starts in May and continues until October. Irrigation water is diverted from the river into a system of canals and reservoirs. These provide important wetland habitat for waterfowl and fish. Improved irrigation techniques have greatly reduced the water required to grow crops, allowing more crop production while using the same amount of water.

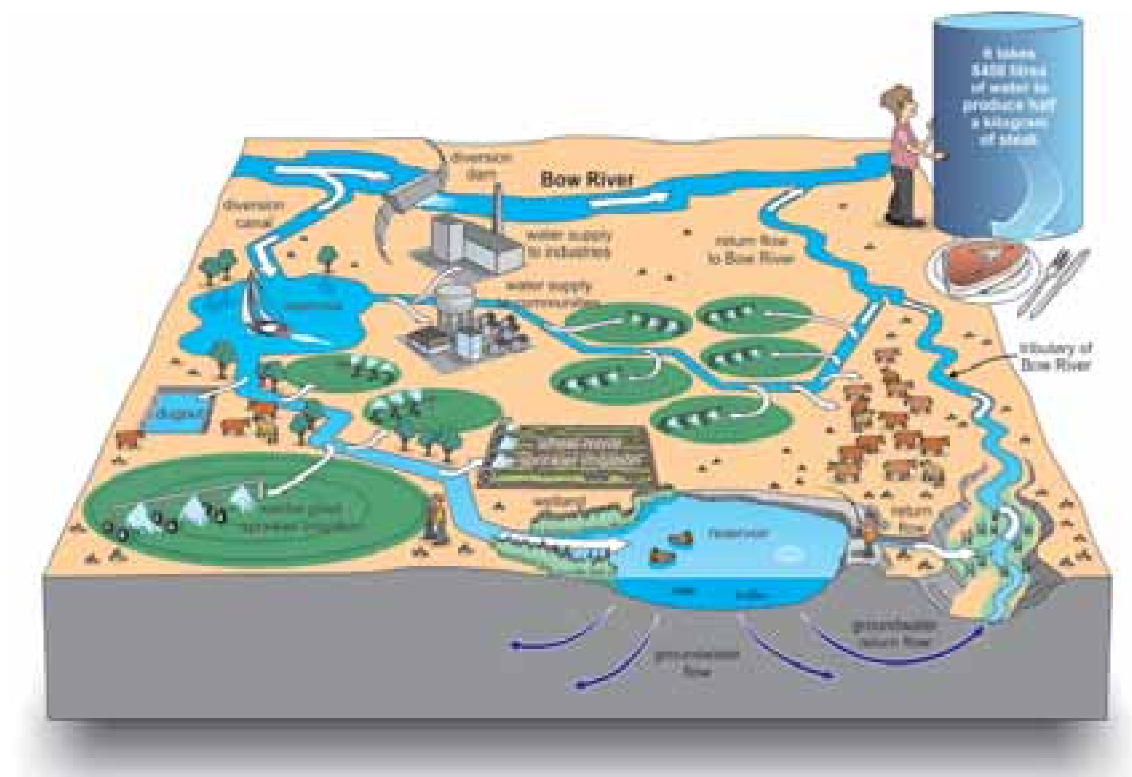


Fig. 54

Irritating Irrigating

Subjects:
Science, Social Studies

Time:
Model – 10 minutes, Observing – over two weeks

Objectives:
Without irrigation, our prairies would be too dry to produce the crop yields that we depend on. However, too much irrigation water can cause problems. Students will see that besides wasting our water resources, excess irrigation can lead to leaching of salts from underground sources. When this happens, irrigation does more harm than good so it is imperative that farmers irrigate carefully and responsibly.

Materials:
Enough for one group of students

- Two 2-L clear plastic bottles (find ones that have a flat bottom – pop bottles don't work well with this activity)
- Marker
- Scissors
- 125 mL (½ cup) salt
- 500-750 mL (2-3 cups) lightly packed dirt
- Measuring cup
- Water
- Spray bottle (optional)
- Fast growing seeds (grass, beans, radish)
- Magnifying glass
- Stems with leaves, glasses , salt (optional for prompt)

PROCEDURE

Prompt:
Although most living things require some salt to survive, you can get too much of a good thing. For humans, a little too much salt will make us violently ill and can even lead to death. For plants, the story is the same. Bring in two fresh cut stems with leaves. Place both in glasses or beakers, one containing 250 mL (1 cup) tap or distilled water and the other containing a solution of 250 mL (1 cup) water to 15 mL (1 Tb) salt. Set aside the glasses for 15 minutes. Have student closely examine the foliage and predict possible causes for the differences observed. Lead the discussion into irrigation and the need for good quality water.

Building the Irrigation Model:
1. Remove labels from two 2-L clear plastic bottles with flat bottoms. Many juices come in these types of bottles.

2. Draw a line around the bottles, approximately 12 cm from the base (see Fig. 55). Cut along the line with a pair of scissors. It is recommended that this step be completed before the lesson rather than having students do this potentially hazardous activity.

3. Place 60 mL (1/4 cup) salt in the bottom of each container (see Fig. 56).

4. Place 500-750 mL (2-3 cups) loosely packed soil on top of the salt. This represents the ground with a deeply buried salt source.

5. "Irrigate the two containers as follows:

   - For container #1, pour 420 mL or 2 1/3 cups of water over the top of the soil.

   - For container #2, pour 60 mL or 1/3 cup of water over the top of the soil.

   - For the subsequent six days, pour another 60 mL or 1/3 cup of water over container #2 every day until the soil has been irrigated with a total of 420 mL or 2 1/3 cups cup of water. Because the conversions between metric and imperial are not exact when dealing with measuring utensils, it is important to use either one or the other in order to control your variables between container # 1 and 2.

ACTIVITY:

1. Have students work in groups. Each group builds an irrigation model and waters it according to directions.

2. In their journal, students will make a prediction about what differences they will see in one week's time.

   1. Students make daily observations of their two models, looking for any indication of change in either one. They should use a magnifying glass to look for any crystals, indicating salt contamination. They may or may not see evidence of contamination at this point.

   2. After one week, students compare their prediction to their observation and predict what will happen to seeds planted in both containers.

3. Plant a few seeds in each container, water lightly (same amount of water for each container) and observe seed germination for a one week period. Make daily observations in the journal. Be sure to discuss controlling variables at this stage. The seeds that are planted in soil that was properly irrigated (not over-watered causing salts to leach up through the soil) will germinate normally while the seeds planted in contaminated soil will not germinate or will do poorly.

4. After one week, deepen student understanding of what has been learned using PERCS critical thinking skills:

Perspective – From whose point of view are you looking at the results (farmer, consumer, plants, scientist?). Try different ones.

Evidence – What evidence do you have that the alternative irrigation methods made a difference? Remember that evidence is "just the facts".

Relevance – So what? What does it matter? Who cares?

Connections – What is the cause and what is the effect? How does this demonstration connect past, present and future?

Supposition – What if….? Could there be alternatives or better ways to irrigate?

Extensions:

- Design and build a prototype of a better irrigation system based on what you have learned.
- Design an experiment where you test different species of plants to see which may be more resistant to the effects of salt concentrations. You could also add plants to the experimental containers.
- Research about irrigation techniques used in arid regions of the world where water is already in desperately short supply. What can we learn from these regions to help us in the future (Israel, Saudi Arabia…)

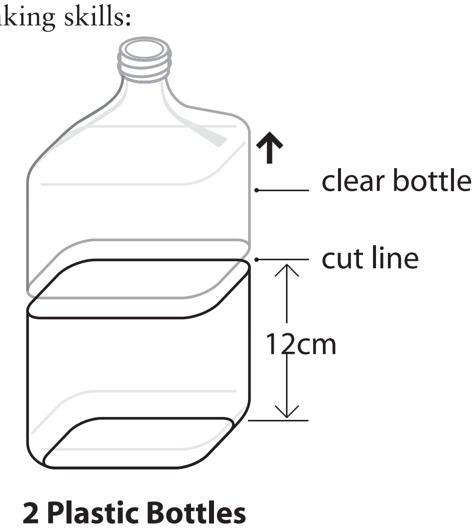


Fig. 55

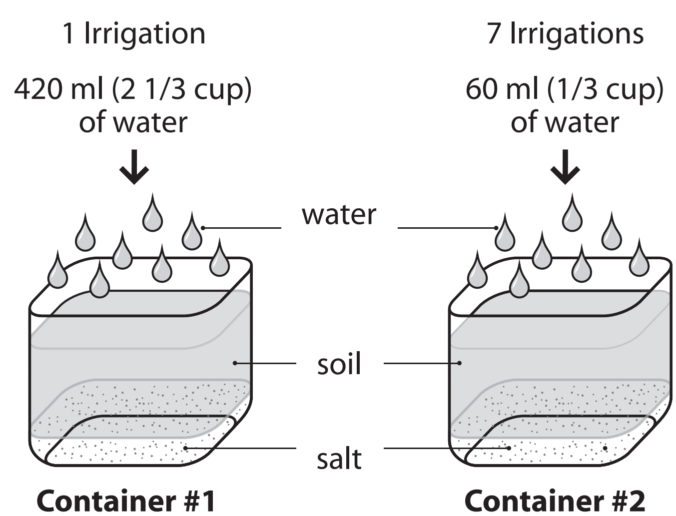


Fig. 56

Keeping the River Clean Panel Activities

BACKGROUND INFORMATION

Out on the range: Managing range land for both cows and healthy streams.

Riparian areas occur along streams and wetlands where moist soils and shallow water tables allow water-loving plant communities to establish. These “green zones” are vital ecosystems in the prairie and foothills that provide habitat for wildlife, stabilize stream banks, and protect water quality. Cattle grazing in riparian areas must be managed carefully so that these delicate landscapes are not degraded.

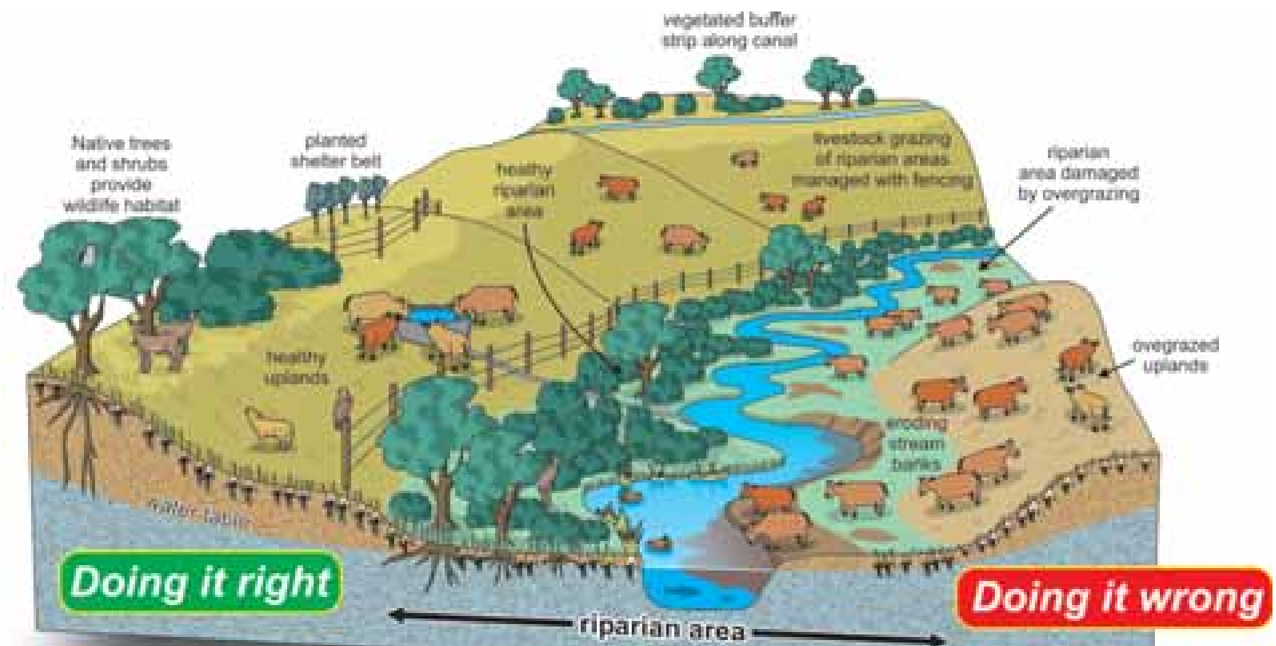


Fig. 57

In the city – stormwater: How bad stuff can get into the river

There is a widespread myth that water that goes down storm drains flows to water treatment plants. This is not true. Storm drains are only meant for rainwater and snowmelt. Many street drains flow through pipes straight to the river.

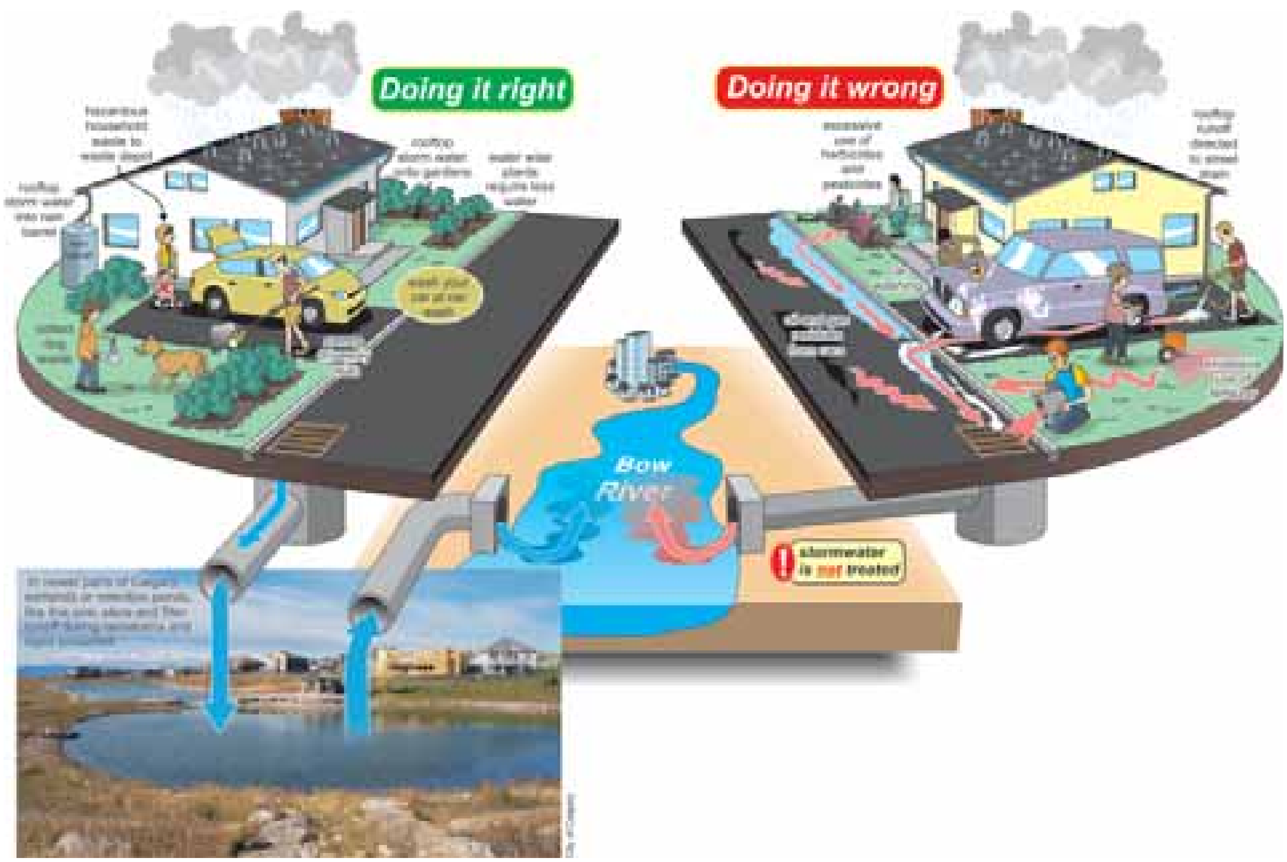


Fig. 58

Flames Flushers

Subjects:
Science, Social Studies

Time:
1 class

Objectives:
Students will gain an appreciation for a well-functioning sewage treatment system as well as an understanding of the importance of avoiding peak "load" periods for waste water handling facilities.

Materials:
- Several refrigerator magnets or magnetic tape cut into small pieces (you can get magnetic tape in any craft department if your refrigerator isn't already covered with magnets
- Magnetic white board – if your classroom doesn't have these yet, get your school board to spring for a white message board.
- 8 cups

PROCEDURE

Prompt:
It is important for students to have some sense of the history of waste disposal when learning about treatment facilities. In light of that, you can introduce this activity with a brief introduction to Mr. Thomas Crapper, a famous English plumber often credited with inventing the toilet, although he probably didn't. He did patent a more efficient flusher back in the late 1800s and his name (Crapper) was seen in many a loo in England. Certain inventor's names become synonymous with their invention – Rubic and his cube, McDonald and his burger, and Crapper and his toilet. World War I soldiers returning from England had seen Mr. Crapper's name wherever they went to the restroom and when they returned home, the name Crapper would become a household word for this absolutely essential component of any civilized society.

Fig. 59

ACTIVITY:

1. Ask students if they watched the 2004 Stanley Cup playoffs or any other shows where a large percentage of the population is watching the same thing. What do they think happens when a commercial comes on? What do people do?

2. On the whiteboard, put the pattern shown here. The solid line represents buried sewer pipes leading to the sewage treatment facility. The dashed line is the treated effluent from the treatment plant to the river. The boxes represent houses along the sewer line and the irregular line at the top represents a river. The circle is the sewage treatment facility.

3. Give eight students cups containing pieces of magnetic tape. On each cup, write the #1, 2, 3 or 4.

4. The rule is, if all waste is treated in 30 seconds there will be no overflow. If a person has to wait more than 30 seconds to put their waste in the sewage treatment plant, the system overflows and the waste goes directly into the river.

5. Tell students that 5 seconds are required to process the waste from each house. Assign one student to stand at the board as a timer. No further sewage (magnetic pieces) can enter the plant until 5 seconds have passed.

6. When the word ”flush” and a number is called, that person brings up a piece of sewage and puts it on the board in the sewage circle. He just flushed! The timer makes sure that only one person per five seconds can put waste in. After five seconds he can move it to the river. Try this a few times with just one number and then start calling out two numbers. Then increase to three numbers and finally, all four at the same time. Students who wait longer than 30 seconds will put their "waste" directly into the river. This represents untreated sewage.

7. Students now discuss if there are times when this could happen and what problems might arise if it does (odour, bacteria, viruses, protozoa, increased algae, decreased oxygen content).

8. Give groups of students copies of "Prairieville Waste Water Disposal Plant braces for Stanley Cup Flames Flushers".

9. Each group will then devise a plan of action to make sure that Prairieville does not have an environmental disaster during "heavy load" periods. Points to consider are:
   a. When might this happen?
   b. How will you get people to cooperate?
   c. How feasible is the plan?
   d. What are the expected results of the plan?
   e. Who will pay?
   f. How clear is the plan?

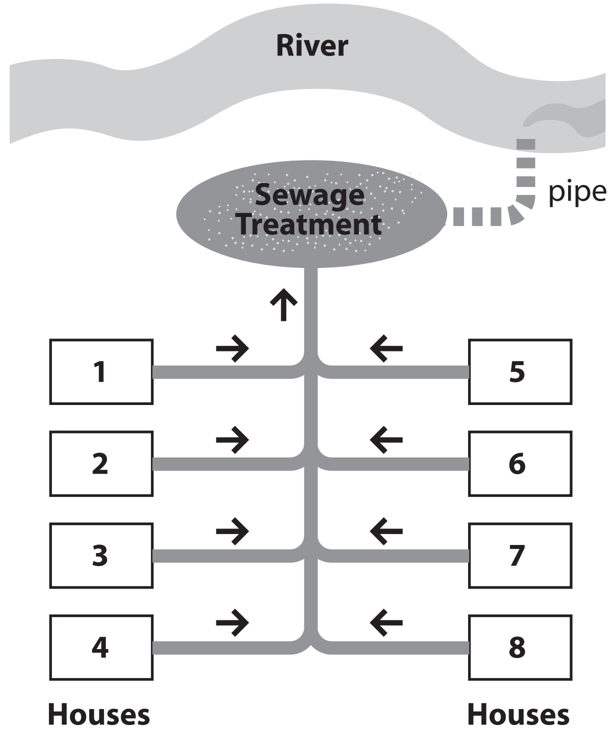


Fig. 60

10. When done, each group does a two minute presentation for the class summarizing their plan.

Extensions:

1. Visit a waste treatment facility.

2. Research about how bioremediation is used to treat sewage. Investigate anaerobic and aerobic examples of bacteria cleaning up the environment.

Prairieville Waste Water Disposal Plant Braces for Stanley Cup Flames Flushers

While most Canadians eagerly anticipate the Stanley Cup playoffs, water treatment plant operators at the Prairieville Sewage Treatment facility dread game time. Each year during the games, at commercial breaks, after goals and between periods, a surge of wastewater rushes into the sewer system, creating a full load at the plant. Plant operators refer to this period as "goal gushers". At Prairieville, sewage crests during these times at 36 mgd (million gallons/day) even though the plant is only designed to handle 35 mgd. So far, there hasn't been an overflow but it is only a matter of time, or a really, really popular T.V. show. An overflow of raw sewage into the Prairie River would create serious health, environmental and economic problems for the communities downstream. Those goalies may just be stopping more than pucks!

All Bogged Down!

Subjects:
Science

Time:
one science period

Key vocabulary:
wetland, watershed, aquifer, groundwater

Objective:
To demonstrate the effectiveness of wetlands in cleansing our water before it enters the groundwater

Materials:
- Plastic groundwater model as used in ”Go with the Flow” activity (page 34)
- Sphagnum moss (dried is available from Michaels or most pet stores)
- Approximately 1 L of water coloured with blue food colouring to represent groundwater
- Cocoa and water for contaminant (approximately ½ tsp/½ cup water)
- Film canister with holes punched through bottom (translucent is best)
- Clear container to catch groundwater flow
- Pop bottle to hold extra blue coloured water

Procedure:
1. Using the plastic groundwater model from Go with the Flow, make a depression and place soaking wet sphagnum moss into the depression to simulate a wetland.

2. Add blue colored water to create a visible water table, and groundwater.

3. Place the film canister on the wetland.

Fig 61. – All Bogged Down! – Wetland

Fig. 62 – All Bogged Down! – polluted wetland

4. Pour cocoa water contaminant into the film canister or “leaky tank”.

5. Observe the contaminant in the film canister, and watch for a plume in the aquifer. (There should be no or very little trickling of the contaminant through the moss.)

6.Remove the cap on the plastic groundwater model, and simultaneously pour blue colored water into the model as the water flows through. Try to maintain the same water table level.

7. Compare the quality of water flowing out of the model to that flowing in.

8. Remove the sphagnum moss, and squeeze it out into a clear container. Compare the color of this water to that of the groundwater.

Extensions:

1. This wetland appears to successfully “clean” the water as it passes through. Why does it work? Would there be other mechanisms at work in a real wetland situation – consider phytoremediation and bioremediation.

2. Research and map the wetland areas in Calgary — both constructed and natural.

3. Discuss the pros and cons of developing natural wetland areas for residential or other use. Try to include a current local example.

4. Assume that you are an environmental scientist for the government of Alberta. Your task is to set a guideline for the maximum level of fecal coliform that should be measured in Alberta rivers. How would you go about determining what the maximum “safe” level seems to be, assuming that you can’t “Google” it (i.e. that it hasn’t been determined by others before you)? Teacher info: Often simple biological indicators are used to determine such levels, i.e. – water with specific fecal coliform levels could be used as a habitat for a particular type of fish typical of the Bow river, and their life span observed, or their ability to reproduce, etc. Students may come up with numerous good ideas.

Bow River Reflections

Subjects:

Fine Arts, Language Arts, Science, Social Studies

Time:

1–2 class periods. This activity is designed to be a culminating reflection process.

Objectives:

At the end of the unit, students should have become very familiar with the Bow River from social, scientific and personal perspectives. They will now be given the opportunity to reflect on their learning and to use three pieces of artwork from which to develop a sense of the river's role through time by linking past, present and future together. This is especially important when considering the current generation's responsibility for ensuring a sustainable water resource for future Albertans, and perhaps even more importantly, for caring for the river that gives us so much.

Materials:

- Various pictures (photographs or paintings/drawings) of the Bow River in different seasons
- A good resource is "The Bow. Living with a River" (Book or art prints available at the Glenbow Museum Gift Shop)

Procedure

1. Divide students into three groups (number off or whatever method works well for the class). Each group will be looking at a different piece of artwork depicting the Bow River. You should have enough copies of each picture so that no more that four students have to share. Tell students whether their work of art represents past, present or future for the Bow River.

2. Allow students to silently reflect on their picture for two minutes (there should be no talking at this stage).

3. Ask students to discuss whether they like or dislike the picture with one other person in their group (or two if there is an odd number).

4. Each group will answer the following questions about their picture. Students are encouraged to be creative, take turns with ideas and reach consensus: (you might want to put these questions on a worksheet to make recording answers easier)

   - What do you see (colours, lines or shapes that stand out)? Decide on three words and write them down.

   - What feelings, sensations or emotions do you have when looking at the artwork? Decide on three words and write them down.

   - What is the story that you see in this work of art? How do the colours help you tell that story?

   - What can you tell from this work of art about the time in which the artist lived?

   - Considering the "time" of your picture, find a hidden message in this work of art.
     What is it and what clues helped you find it?

5. Take 15 minutes to create a two minute movement presentation (skit, tableau, living sculpture, etc.) OR an original work of art. The presentation should show your understanding of the following concepts:

- The story of the Bow River during your chosen time period (past, present or future)
- A concern that you have based on your interpretation of the artwork.
- A reason for optimism that you have based on your interpretation of the artwork.

Movement presentation or work of art will be shared with the class.

6. As each group finishes their sharing, the audience is invited to give feedback on how it values the piece, insights gained and questions that it evoked. Keep questions to a maximum of five or six before moving on.

7. Students will reflect on what they have learned in their personal journals. Questions might be:

   - If you could ask a question of the artist about the Bow River, what would it be?
   - How is your own life (past, present and future) connected to and dependent on the Bow River?
   - The "Golden Rule" says to "do onto others as you would have them do unto you". How does this message relate to the Bow River?

Resources

Professional Development

- **Calgary Science Network Teacher Workshop Program –** workshops and fieldtrips presented on topics integral to the Alberta Learning Science Curriculum, as well as general sessions that combine emphases on social studies or language arts with science topics. Each workshop has two leaders: a scientist to ensure relevant content and in-depth subject knowledge, and an experienced educator to guarantee that activities and materials are grade appropriate and practical in a classroom or field trip setting. http://www.calgarysciencenetwork.ca/pdworkshops.html

- **Inside Education –** sponsored institutes for teachers including Bow River Ecotour and Water Education Institute. http://www.insideeducation.ca/html/proDevApp.html

Guest Scientists

- **Calgary Science Network Scientist in the Classroom –** brings science to life for thousands of Calgary area school children through an array of programs, including Scientist in the classroom, Science Fair judging, guidance for scientific field trips, science career awareness and mentoring, enrichment ideas, science questions answered and science speakers. http://www.calgarysciencenetwork.ca/scivisit.html

Internet

- **Agricultural impacts on surface water quality in the irrigated areas of Alberta –** Alberta Agriculture: Irrigation Branch http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr4451/$file/ib001-2000.pdf?OpenElement

- **Alberta Environment: Alberta's River Basins –** Detailed information on Alberta's river basins. http://www3.gov.ab.ca/env/water/basins/basinform.cfm

- **Alberta Environment Land Reclamation –** http://www.gov.ab.ca/env/land.html

- **Atlas of Alberta Lakes –** Includes information on drainage basin, water quality, and biological characteristics. http://sunsite.ualberta.ca/Projects/Alberta-Lakes/

- **Bioremediation –** U.S. Environmental Protection Agency www.clu-in.org/s.focus/c/pub/i/59/

- **The Bow River Basin Council (BRBC) –** a charitable organization dedicated to conducting activities for the improvement and protection of the waters of the Bow River Basin. Excellent source of maps, data and other information. http://www.brbc.ab.ca/index.asp

- **City of Calgary Waterworks –** information on a variety of water conservation and quality issues, activities, links - http://content.calgary.ca/CCA/City+Hall/Business+Units/Waterworks/index.htm\

- **Environment Canada Freshwater Website –** links, information and more. http://www.ec.gc.ca/water/e_main.html

- **Faculty of Science, Environmental Science, 4th Year Class Projects –** http://www.fp.ucalgary.ca/ENSC/research_projects.htm
- **Focus on Inquiry –** Book from Alberta Learning http://www.education.gov.ab.ca/K_12/curriculum/bysubject/focusoninquiry.pdf
- **Geologcial Survey of Canada –** Creators of the Bow River Basin Waterscape poster. Visit their educational website at http://gsc.nrcan.gc.ca/edumat_e.php
- **Geoscape Posters –** posters by the Geological Survey of Canada describing the geological landscapes of many cities and regions of Canada http://www.geoscape.nrcan.gc.ca
- **How Stuff Works –** http://www.howstuffworks.com
- **Nose Creek Watershed Partnership –** Water quality data for Nose Creek Watershed http://www.airdrie.com/Content/environment/nosecreek
- **Phytoremediation –** U.S. Environmental Protection Agency www.cluin.org/products/citguide/phyto2.htm
- **Sierra Legal –** source for Waterproof: Canada's Drinking Water Report Card which reports on safety of Canda's drinking water. http://www.sierralegal.org/issue/waterproof.html
- **Trout Unlimited Canada –** source of information for conservation and restoration of Canadian freshwater ecosystems. Home of Yellow Fish Road which is a nation-wide environmental education initiative. In-class materials for educators including lesson plans and activity booklets. The Yellow Fish Road Kit is also available. http://www.tucanada.org/
- **United States Geological Survey Water Science for Schools –** information on a variety of water conservation and quality issues, activities, links - http://ga.water.usgs.gov/edu/
- **Water for life –** Alberta government strategy for sustainability (document is downloadable), information on water conservation. http://www.waterforlife.gov.ab.ca/
- **WaterQuest –** Alberta Agriculture, Food and Rural Development interactive web site http://www.waterquest.ca

Field Trips

- **Bow Habitat Station (at the Sam Livingston Fish Hatchery) –** Investigate water conservation and find out how each part of a water treatment plant works in the Dripper in the Liquid Lesson school program. Located along the Bow River, the Bow Habitat Station features a freshwater and fish interpretive centre, a trout hatchery, and a unique collection of wetlands, interpretive trails, and school programs. Grades: 4 – 9.
  http://www3.gov.ab.ca/srd/regions/southeast/bowhabitat/ Contact: (403) 297-6561

- **Alberta RiverWatch –** helps science classes to explore a 10 km section of their local river during a raft float trip. Along the way, students make shoreline stops to conduct water chemistry and biology tests. Back at school, the water quality data is used to answer the question, "How healthy is your river?" Grades 7 – 12. For bookings call - Edmonton 780-454-4347, Calgary 403-590-5330 or toll free 1-888-993-6300
  http://www.riverwatch.ab.ca/ Contact: (403) 221-8360

- **Inglewood Wildlands –** The Wildlands is a special place created by a community as a response to a technological problem — oil from the refinery has percolated through the gravelly soils and accumulated on the water table about 5 metres below ground surface. It is an environment where students can contemplate human impact on the landscape, appreciate the results of a community vision, understand recovery and reclamation processes, explore nature, and embrace a sense of stewardship for the environment. Calgary teachers have the opportunity to use this unique site as a catalyst for learning, which will augment on-going studies at their own school. Application forms and further information are available on the website www.inglewoodwildlands.ca.

Posters

- **The Winds of Change: Climate change in Prairie Provinces –**
  poster has an accompanying teacher guide which is downloadable at http://adaptation.nrcan.gc.ca/posters/teachers/guide_e.asp - poster available through Geological Survey of Canada Bookstore, 3303 33rd St. N.W., Phone 403 292-7030.

- **Geoscape Posters –** posters by the Geological Survey of Canada describing the geological landscapes of many cities and regions of Canada http://www.geoscape.nrcan.gc.ca

Books

- ***The Bow: Living with a River,*** published by the Glenbow Museum –
  Explores the past, present and future of the Bow River through art and essay.
  ISBN 1552636348

- ***Rivers for Life: Managing Water for People and Nature*** by Sandra Postel, Brian Richter – Rivers for Life presents a global perspective on the challenges of managing water for people and nature, with a concise yet comprehensive overview of the relevant science, policy, and management issues. It presents exciting and inspirational information for anyone concerned with water policy, planning and management, river conservation, freshwater biodiversity, or related topics. ISBN: 1559634448

Equipment/Materials

- **Boreal Laboratories Ltd. –** Chemical Testing Equipment and Kits
  http://www.boreal.com

- **Plastic Groundwater Model** from the Colorado School of Mines
  http://www.mines.edu/Outreach/Cont_Ed/esrc.shtml

Glossary

agriculture: the occupation, business, or science of cultivating the land, producing crops, and raising livestock.

aquifer: any rock or sediment that yields a useful amount of water through wells and springs.

atmospheric water: the water that exists in the atmosphere (air), either as water vapour or precipitation before reaching the earth's surface.

bioremediation: the use of biological means to restore or clean up contaminated land, for example, by adding bacteria and other organisms that consume or neutralize contaminants in the soil.

Bow River Basin: this is the land that drains all precipitation received as runoff or groundwater into the Bow River and its tributaries. The Bow River basin drains eventually into the Hudson Bay.

canal: an artificial waterway constructed for use for irrigation, or for recreational use; also known as a diversion canal.

chlorine (Cl): a gaseous, poisonous, corrosive, greenish-yellow chemical element that combines with nearly every other element. It is widely used to purify water and as a disinfectant.

cistern: an underground tank for storing rainwater.

condensation: tiny drops of water that form on a cold surface such as a window when warmer air comes into contact with it. The process where a vapour loses heat and changes into a liquid.

contaminant: a substance, such as a toxin or chemical, that leaches into the ground, polluting it and possibly the groundwater and drinking water.

continental divide: a massive area of high ground in the interior of a continent, from either side of which a continent's river systems flow in different directions.

contour interval: the interval between contour lines on a map, or the altitude the interval represents.

contour line: a line on a map connecting points on a land surface that are the same elevation above sea level.

dam: a barrier that is built across a river or stream to block, control, or redirect the flow of water (diversion dam), especially in order to create a reservoir.

desalinization: the process of removing salt from water, usually seawater, to produce potable water.

dissolved oxygen: the amount of oxygen dissolved in water, in parts per million (ppm) by weight, or in milligrams per litre (mg/l). Low levels of dissolved oxygen can be disastrous for local fish and ecosystems.

drought: a long period of extremely dry weather when there is not enough rain for the successful growing of crops or the replenishment of water supplies.

dugout: a depression excavated to collect rainwater and/or water from a neighbouring stream as a water supply for livestock; a common practice amongst farmers in the prairies.

effluent: liquid waste discharged from a sewage system.

evaporation: a process where water is changed from a liquid to a vapour.

evapotranspiration: the return of moisture to the air through both evaporation from the soil and transpiration by plants.

fecal coliform: rod-shaped bacteria normally found in the colons of humans and animals and can become a serious contaminant when found in the food or water supply (e.g. E. coli).

flow rate: the volume of water that flows in a given amount of time, for example: m^3/s (cubic metres per second).

foothills: low lying hills extending from a mountain range. The local foothills are a result of a series of thrust faults that also formed the Rocky Mountains.

freshwater: inland waters, such as, rivers, ponds, wetlands, and lakes, with little or no salt content.

glacier: a large mass of ice formed on land by the compaction and recrystallization of snow, creeping downwards due to the stress of its own weight, and surviving from year to year.

global warming: an increase in the world's temperatures, believed to be caused in part by the greenhouse effect and depletion of the ozone layer.

groundwater: the water (rain and snow) that infiltrates the ground, filling the cracks and pores within the underlying rock and sediment. This 'under ground' water completely fills the spaces within the rock and soil below the water table.

headwaters: the streams that make up the beginnings of a river.

habitat: the natural environment in which a plant or animal lives; such as a forest, prairies or wetlands.

hydroelectric (hydro) power: electrical energy generated by means of a power generator coupled to a turbine through which water passes.

icefield: an extensive area of interconnected glaciers in a mountain region; for example, Columbia Icefield.

infiltration: the movement of water, into soil or porous rock.

irrigation: when the land is too dry to sustain an agricultural industry, water is moved from local rivers (i.e. Bow River and tributaries), through a system of canals and storage reservoirs, to supply water to farmers.

lake: a large body of water, in a depression, surrounded by land.

leaching: when water dissolves soluble, potentially hazardous, material and transports it into the ground and risking water supply contamination.

mountains: any part of the Earth's crust higher than a hill, generally projecting at least 300 m (1000 ft) above the surrounding land; for example, the Rocky Mountains.

nitrate: a compound used as fertilizer that may consist of sodium nitrate, potassium nitrate or ammonium nitrate. Nitrate levels can be measured in soil and water.

oil well: a shaft drilled into the earth through which petroleum (crude oil) is extracted.

oilfield injection: the practice of injecting water (steam) into oil wells to increase oil recovery.

pH: a measure of the acidity($pH<7$) or alkalinity($pH>7$) of a solution, such as vinegar, or a damp substance, such as soil.

phosphate: any salt formed by the reaction of a metal with phosphoric acid. Once found in detergents, but phosphates are now more regulated due to the negative impact on water ecosystems.

phytoremediation: the process of decontaminating soil by using plants to absorb heavy metals or other pollutants.

plant transpiration: loss of water vapour through a plant's surface, especially through minute surface pores (stomata).

plume: referring to a pipe-like body of contaminant that has leached into the earth, possibly reaching the water table and contaminating the groundwater and potable water supply.

potable water: water that is safe and palatable for human use.

prairie: an extensive tract of level to rolling grassland, generally treeless, in the temperate latitudes of N. America, characterized by a deep, fertile soil and by a covering of tall, coarse grass and herbaceous plants.

precipitation: rain, snow, or hail formed by condensation of moisture in the atmosphere that falls to the ground.

rain shadow: a very dry region on the side of a mountain range facing away from the wind (leeward side), where rainfall is noticeably less than on the windward side. The rain shadow falls just east of the Rocky Mountains onto the prairies, leaving the prairies relatively dry.

raw sewage: human and domestic waste matter from buildings, especially houses, that is carried away through sewers to be treated at special treatment facilities.

reservoirs: a large natural or artificial lake used for collecting and storing water for human consumption or agricultural use, such as the Glenmore Reservoir, Calgary.

retention pond: a wetland created to store and filter runoff during rainstorms and rapid snowmelt.

riparian area (green zones): parts of the landscape strongly influenced by water, flood plains adjacent to streams and rivers, where water-loving plants grow. Riparian areas are sensitive ecosystems that need to be managed carefully to prevent erosion.

river: a natural formation in which fresh water forms a wide stream that runs across the land until it reaches the sea or another area of water, such as, another river or lake.

saltwater: ocean or sea water with noticeable levels of salt (non-potable).

sewage (waste) treatment plant: a facility where sewage or waste water is collected, and cleaned before returning to a river and heading downstream. Calgary has two sewage treatment plants: Bonnybrook and Fishcreek. Calgary's sewage/wastewater undergoes a number of processes, including:

- **Headworks:** screens that remove large material from wastewater
- **Primary clarifiers:** used for settling and skimming
- **Bioreactors:** good bugs that use sewage for nutrients
- **Secondary clarifiers:** removal of good bugs
- **Digesters:** anaerobic decomposition of sewage (i.e. bacteria)
- **Disinfection UV:** makes any remaining micro-organisms sterile so they cannot reproduce and phases out chlorine
- **Treated effluent:** cleaned water returned to the Bow River
- **Sludge:** biosolids in a slurry sent to Shepard lagoons to settle
- **CALGRO:** takes treated biosolids to farms to be used as fertilizer

snowmelt: runoff produced when snow melts. Most of the Bow River's water supply comes from snowmelt.

snowpack: The fresh snow deposited yearly that contributes to the melt waters leading to streams and rivers.

soil porosity: referring to the minute spaces within soil that enables it to absorb water.

South Saskatchewan River Family: the tributaries leading into the South Saskatchewan River, namely: the Bow, Red Deer and Oldman rivers.

stormwater: refers to all forms of precipitation (rain, snow, sleet) which becomes runoff or enters the earth as groundwater. People are encouraged to make better use of rooftop stormwater by collecting it in rain barrels or redirecting it directly onto gardens.

surface water: the part of precipitation appearing on the surface as runoff.

transpiration: the loss of water vapour from a plant's surface through minute surface pores called stomata.

treated sewage: raw sewage treated at special treatment facilities. Experimental use of treated sewage to fertilize farmland is currently underway.

tributary (pl. tributaries): any stream that contributes water to another stream.

water conservation: the practice of protecting the current water supply by reduction of water consumption within the home, at work, in agriculture, or in industry (e.g. water-efficient appliances, toilets, irrigation systems, water-wise gardens).

water cycle: the constant circulation of water between atmosphere, land, and sea by evaporation, condensation, precipitation, and percolation through soils and rocks as groundwater.

water quality: The fitness of water for use, being affected by physical, chemical and biological factors. Calgary's tap water rates high in water quality when compared to other urban centres.

water table: the surface between the zone of water saturation or groundwater (below) and the zone of aeration (above).

water tower: a tower for water storage.

water treatment plant: a facility where water is collected, cleaned and made potable by a municipality for human consumption. Calgary has two water treatment plants: Bearspaw and Glenmore.

water well: a well that extracts groundwater for surface use, either for irrigation, industrial use or as a potable water source.

watershed: another name for a drainage basin where water drains and collects into a series of tributaries feeding into a common river.

wetland: a marsh, swamp or other area of land where the soil near the surface is saturated or covered with water, especially one that forms a habitat for wildlife.

