Get To Know Your Watershed!

A Teacher Resource Guide for Northern Watershed Education

ECOLOGY NORTH

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

Get to Know Your Watershed!

A Teacher Resource Guide for Northern Watershed Education

This Teacher Resource Guide was developed for northern teachers and organizations to help teach and engage students in learning about watersheds.

The guide was developed by Ecology North with financial support from Environment and Natural Resources, Government of the Northwest Territories. It has been released for Canada Water Week 2015.

Watersheds are important features in our landscape that teach us about how water flows, how rivers are created and how land and water ways are connected. Other topics such as geology, weather, topography, land cover, land uses and water quality can also be incorporated when teaching students about watersheds.

The guide provides background information about watersheds and their features and functions, with an emphasis on watersheds in the Northwest Territories (NWT). The background material also includes a list of key watershed terms (bolded words), and additional books, video and website resources.

Three watershed-related lessons are laid out in this guide. Each lesson is designed to engage students in a hands-on and interactive watershed model building activity. Through the lessons students learn by doing, thinking, researching and experimenting. The three lessons range in grade level and duration, from a 60 minute upper elementary lesson, to a multi-session high school lesson. Several assessment and extension options are provided for each lesson .

Navigating the Guide

Table of Contents

Background Material

What is a Watershed?

[i]

Every piece of land on earth is part of a **watershed**. A watershed, which is also known as a **catchment basin**, is an area of land that catches **precipitation** that eventually drains into the same **body of water**. When water falls on the earth's surface—usually in the form of rain or snow—the water flows **downstream**. As the water moves **downstream**, it forms creeks and streams that always flow into larger streams and rivers. The water continues to travel until it eventually reaches the same **body of water**, such as a lake or ocean. The land that the water flows through on its way to that **water body** is called a **watershed**.

The water that flows through a watershed can travel across the land as **surface run-off**, or flow under the land as **sub-surface run-off**. **Surface run-off** refers to water that flows over the surface of the land because the water cannot **infiltrate** (move through) into the ground. The water that flows over the earth's surface is the water that eventually flows into streams, rivers and lakes. Trees and other types of vegetation can also soak up some of the water. The water that **infiltrates** (moves through) into the ground is called **sub-surface run-off** water.

As the water seeps into the ground, it fills the tiny cracks and spaces in the sand, soil and rocks below the earth's surface. The distance the water will seep into the ground depends on: 1) the amount of space there is between the rock and soil (**porosity);** and 2) how much water is already in the ground (**saturation**). If there is a lot of space between the rock and soil (high **porosity**), and there is not much water in the ground already (low **saturation**), then the water will be able to seep deeper into the ground. **Groundwater** is the term used to describe the water that seeps into the ground and slowly flows underground over time.

Background Material

How Big is A Watershed?

Watersheds come in many different shapes and sizes. They can be as small as an area that drains into a local creek, or as large as the **Mackenzie River Watershed** (Figure 1), which spans a massive 1,805,200 square kilometers! The size of a watershed depends on the boundaries and reference points that are used to define it. **Watershed boundaries**, which are commonly called **drainage divides**, are high points on the landscape, such as ridges or hills that channel water towards the path of least resistance – downward. These high points act as boundaries that separate watersheds from each other.

Figure 1: Map of Mackenzie River Watershed [ii]

For example, the **Mackenzie River Watershed** drains water from northern British Columbia, northern Alberta, northern Saskatchewan and most of the Northwest Territories, and channels water into the Arctic Ocean. However, this water is not able to enter the Pacific Ocean because the Mackenzie Mountains act as the **drainage divide** that forces the water north rather than west.

Within the **Mackenzie River Watershed** there are many smaller watersheds known as **sub-basins.** The map in Figure 2 highlights the six smaller watersheds, including the Peel, Mackenzie-Great Bear, Slave, Liard, Peace and Athabasca sub-basins. Within each of these sub-basins, there is one **water body** where all of the water within the sub-basin will end up. For example, all of the water that falls into Great Slave Lake sub-basin will eventually collect in Great Slave Lake. The Mackenzie Main sub-basin begins at the outlet of Great Slave Lake, which is also the mouth of the Mackenzie River.

Figure 2: Map of Mackenzie River Watershed Sub-Basins. [iii]

Background Material

What Does a Watershed Look Like?

Every piece of land on earth is part of a watershed. Watersheds can vary dramatically in shape and size, and can have many different features that make them look different from one another. Watersheds are more than just water and are made up of many components. Some of the common features we find in watersheds include rivers, lakes, streams, ponds, oceans, forests, rocks, mountains, farms, towns, recreational areas, parks, communities and cities. Watersheds also include the animals, plants, trees and people that live within them. Watersheds can be located in urban areas, which are most common in southern Canada, or in more remote and wild areas like most of the Northwest Territories. Every watershed has a different pattern of rivers and streams that are defined by the features present on the land, as well as the topography and terrain of the landscape. Just like a snowflake, every watershed is different!

Where does the water in a watershed come from?

Watersheds receive water through **precipitation** that falls on the earth. To know where water comes from, it is important to review the **water cycle** (Figure 3). The **water cycle** describes the continuous movement of water between the land, atmosphere and oceans. The sun is the driver of the **water cycle**, which heats the water in rivers, lakes, oceans and plants. Once it is warm enough, the water evaporates as **water vapour** into the air. This is called **evaporation**. Because **water vapour** is warmer, it weighs less than cold air and rises. As it rises, the **water vapour** cools, and over time changes back into liquid water droplets. This is called **condensation**. As air currents move the droplets around, they collide and grow into clouds, and eventually fall as **precipitation.** Some of the **precipitation** water will run off and end up back in surface water bodies, and some will permeate through the ground. Plants can also absorb water through their roots and release it through their leaves through **transpiration**. The cycle then repeats.

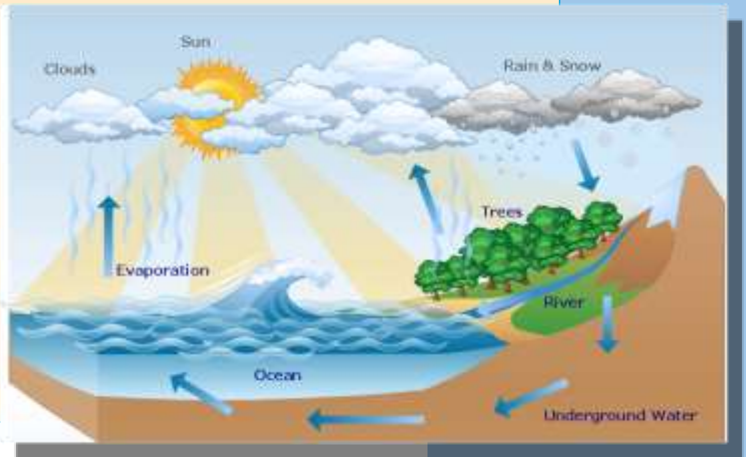


Figure 3: Water Cycle Diagram [iv]

Background Material

Why Are Watersheds Important?

Watersheds provide all the water we depend on. Watersheds provide water for human consumption, such as drinking and industrial processes, and for the ecosystem, including plants and animals. Watersheds are very sensitive to pollution, because all water in a watershed eventually flows into the same place. The continuous flow of water through watersheds means that pollution in one watershed could not only affect the **water quality** of that specific watershed, but potentially **downstream** watersheds as well.

Humans can pollute watersheds in many ways, including industrial pollution, agricultural run-off, erosion and untreated sewage. Pollutants within a watershed can be very harmful to the environment, wildlife, habitat and people that depend on the watershed.

Humans can also change the amount of water that flows through a watershed (**water flow**). **Dams**, which are barriers designed to hold back the water in a river, are common structures that can change the amount of water that flows through a watershed. When a **dam** is holding back water, it reduces the amount of water that flows towards the people, plants and animals **downstream**. Humans can also impact **water flow** by directly extracting water from rivers and lakes. Common uses for this water include irrigation, industry, flood control and drinking water treatment. In extreme cases, over-extraction can lead to low **water levels**, which are a serious concern for the people and ecosystems that depend on the watershed.

Everyone has a responsibility to make sure their actions are not harming watersheds—**water quality** and **water quantity**, as well as plants, fish and wildlife. This responsibility is called **water stewardship**. The need for **water stewardship** in the Northwest Territories is recognized in the Northern Voices, Northern Water: NWT Water Stewardship Strategy (GNWT 2010), which lays out a plan for working together to protect watersheds in the Northwest Territories. To learn more about **water stewardship** in the Northwest Territories, visit http://nwtwaterstewardship.ca.

Background Material

What is Source Water and Why is it Important?

We all know water is critical to all aspects of our lives, and understand the importance of a safe and reliable water source for **ecosystem** and human health.

In the North, our drinking water comes from lakes, rivers, streams and, in some cases, **groundwater** sources. All of these sources of water are connected in a **watershed** through the **water cycle** (see previous section). However, drinking water sources can be easily contaminated by various sources of **pollution**. Examples of water pollution sources in the Northwest Territories include:

- contaminated run-off water and direct **wastewater** discharge from industrial activities in the Northwest Territories, such as mining, oil and gas extraction and exploration
- contaminants from upstream land use activities, such as industrial and agricultural activities in Alberta
- sewage and landfill contamination through run-off water
- fuel spills or leaks

In order to make sure we have enough clean water to drink, we need to protect the **body of water** our drinking water comes from. The specific **body of water** a community uses to supply their drinking water system is called **source water**.

Figure 4: Source Water Area Sign [v]

The best way to protect **source water** is on a **watershed** level. This is because water in a **watershed** flows continuously **downstream** until it collects in the same place. For this reason, we need to be careful about how the water is being used **upstream**.

Upstream land use activities can affect both the **quality** and **quantity** of the water supplied to **downstream** users. For this reason, we have to protect the whole **source water watershed** if we are going to protect a **source water supply**. A **source water watershed** includes all of the land that water flows across or under on its way to the community's **source water body**. This concept of protecting **source water** bodies for drinking water is called **source water protection**.

Background Material

Source Water Cont.

In many Canadian cities, signs are posted to make people aware they are in a **source water** protection area (Figure 4). The signs remind people to pay extra attention to how they are impacting the water in the area, and to report any spills.

For each community in the Northwest Territories, the Government of the Northwest Territories has identified the community's **source water body**, and mapped the associated **source water watershed**. The maps are available through the Government of the Northwest Territories Centre for Geomatics at http://www.geomatics.gov.nt.ca/maps.aspx?i=8.

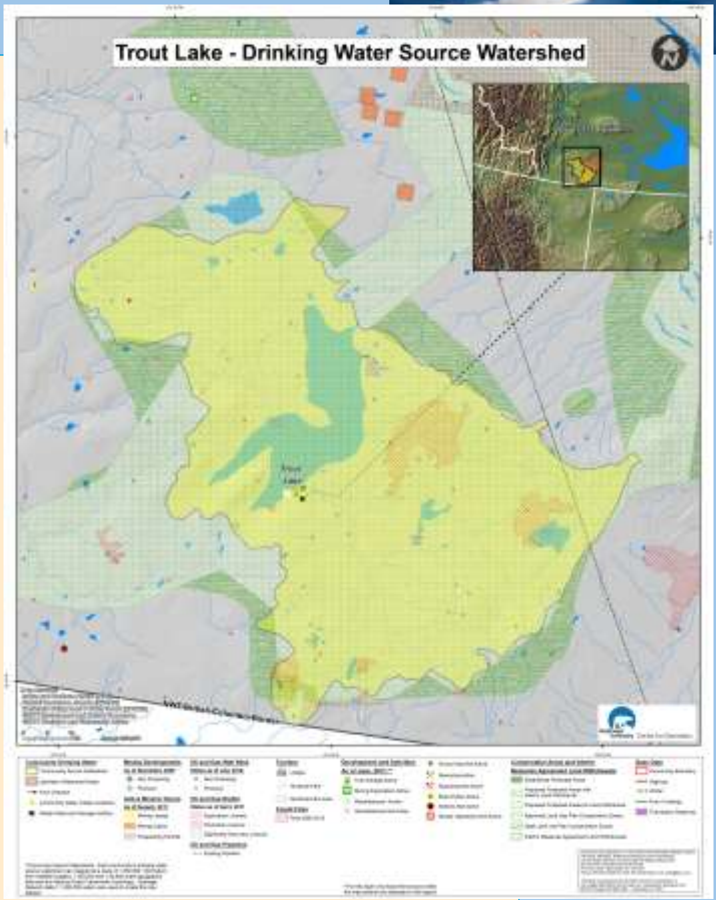


Figure 5: Map of Trout Lake Drinking Water Source Watershed [vi]

What are Topographic Maps and How do they Relate to Watersheds?

Topographic maps represent changes in elevation on a flat paper surface. Although they are two-dimensional, **topographic maps** are able to show three-dimensional landscapes through the use of **contour lines**. **Contour lines** are imaginary lines that connect points that are the same elevation on the land. Therefore, if you were to walk along a contour line, you would not go up or down - you would be walking along the same elevation. **Contour lines** are spaced at regular intervals on **topographic maps**. Therefore, the closer together the **contour lines**, the steeper the slope. Some basic rules about **contour lines** are listed on the next page.

Background Material

Topographic Maps Cont.

- Contour lines near the upper parts of a hill or mountain form closed contours. The peak of the hill is higher than the highest closed contour.
- Contour lines are spaced further apart on gentle slopes.
- Contour lines are spaced closer together on steep slopes.
- Contour lines are evenly spaced when the slope is uniform.
- Contour lines never cross or intersect each other unless there is an overhanging cliff.
- Where contour lines cross a stream, river or valley, they bend to form a “V” or “U” that points upstream or up-valley.

Topographic maps are a convenient way to visualize flat and steep terrain, especially for hikers or other people navigating through a landscape. However, because **topographic maps** show elevation changes, they are also often used to determine **watershed boundaries**. As mentioned earlier, areas of high elevation, such as mountains or ridges, act as boundaries that separate **watersheds** from each other.

Key Watershed Terms

Body of Water	Any significant accumulation of water on the earth's surface, including lakes, rivers, oceans, gulfs, straits, and channels.
Catchment Basin	Another word for "**watershed**".
Condensation	The process where the physical state of water changes from **water vapour** (a gas) into water (a liquid).
Contour Lines	Imaginary lines that connect points of the same elevation on the land. The contour interval refers to the elevation difference between adjacent **contour lines**.
Dams	A barrier that is built to hold back water and raise its **water level**. The general purpose of a **dam** is to retain water, which ends up creating a reservoir.
Downstream	Describes the direction towards the outlet of a river, or the way in which the current flows. Also commonly referred to as 'downriver'.
Drainage Divide	The boundary that separates one **watershed** from another; the high point in a landscape that separates adjoining **watersheds**.
Evaporation	The process where the physical state of water changes from water (a liquid) into **water vapour** (a gas).
Groundwater	The water that is located below the earth's surface in the cracks and spaces in soil, sand and rock.
Infiltrate	When a liquid is able to pass through the openings of a solid, for example, when water is able to move through soil.

Key Watershed Terms

Mackenzie River Watershed — Canada's largest **watershed**; it drains 20% of Canada's land mass, including waters from northern British Columbia, Saskatchewan, Alberta and the Northwest Territories.

Pollution — The presence of a harmful or poisonous substance in an environment.

Porosity — A measure of how much empty space there is within a material. For example, a rock with high **porosity** will have lots of space between grains or within the cracks of the rock. These spaces allow liquid to move through the material.

Precipitation — Any form of water, such as rain, snow, sleet or hail that falls to the earth's surface.

Saturation — Refers to the point at which a substance cannot absorb anything more. With soil, **saturation** occurs when all of the pores in the soil are filled (for example after a rainfall), and thus cannot absorb any more liquid.

Source Water — The raw **body of water** (or **groundwater**) that supplies drinking water systems.

Sub-Surface Run-Off — Water that seeps into the ground and flows beneath the earth's surface.

Surface Run-Off — Water that flows over the surface of the land because the water is unable to infiltrate into the ground.

Topographic Map — Type of map that shows elevation changes in an area. Although the map is two dimensional, it represents a three dimensional landscape through **contour lines**.

Key Watershed Terms

Transpiration — The process where plants release water into the atmosphere.

Wastewater — Any water that has been adversely affected in quality by human influence.

Water Body — Any significant accumulation of water forms a **water body**. Examples include lakes, streams, or rivers that receive surface run-off water.

Water Cycle — Describes the continuous circulation of water between the earth's land, atmosphere and oceans.

Water Flow — A measure of the amount of water that is moving through a system (such as a **watershed**), per unit of time.

Water Level — A measure of the height reached by the water in a **body of water**. **Water levels** are usually higher after a large rainfall.

Water Quality — Refers to the chemical, physical and biological characteristics of water. There are standards of **water quality** for each of these three characteristics that are used to measure water conditions and water health.

Water Quantity — Refers to the amount of water available for a specific use.

Water Stewardship — Recognizes that people are part of the environment and that they have a responsibility to ensure their actions are not harming water.

Water Vapour — The gaseous state of water.

Watershed — An area of land that catches **precipitation** and eventually drains into the same **body of water.**

Watershed Boundary — Another word for "**drainage divide**".

Additional Resources

Books

Water in Rivers and Lakes by Issac Nadeau

Published by Powerkids Press, 2003

ISBN 13: 9780823962662

Watersheds: A Practical Handbook for Healthy Water by Clive Dobson and Gregor Beck

Published by Firefly Books, 1999

ISBN-13: 978-1552093306

What is the Water Cycle by Louise Spilsbury

Published by Rosen Publishing, 2014

ISBN: 9781622752614

A Drop of Water by Gordon Morrison

Published by Houghton Mifflin Co., 2006

ISBN-13: 978-0618585571

Rivers by Geraldene Wharton

Published by World Book In, 1996

ISBN: 0-7166-1752-8

Where the River Begins by Thomas Locker

Published by Puffin, 1993

ISBN: 0140545956

Videos

What is a Watershed?

https://www.youtube.com/watch?v=QOrVotzBNto

What is a Watershed and Why Does it Matter?

https://www.youtube.com/watch?v=f63pwrMXkV4

The Water Cycle

https://www.youtube.com/watch?v=al-do-HGuIk

Cold Amazon: The Mackenzie River Basin

http://gordonfoundation.ca/water/mackenzie-river-basin-initiative/cold-amazon

Life Source: Ensuring Safe Drinking Water in the NWT

http://www.hss.gov.nt.ca/publications/video/life-source-ensure-safe-drinking-water-nwt

Websites

Schools for a Living Planet: Northern Waters (linked to NWT curriculum)

http://schools.wwf.ca/Lessons/Grade/8/157

Northern Voices, Northern Waters: NWT Water Stewardship Strategy

http://nwtwaterstewardship.enr.gov.nt.ca

NWT Drinking Water Source Watershed Maps

http://www.geomatics.gov.nt.ca/maps.aspx?i=8

Canadian Geographic Interactive Watershed Map

http://www.canadiangeographic.ca/watersheds/map/?path=english
watersheds-list

Mackenzie River Basin Initiative: Watersheds 101

http://gordonfoundation.ca/water/mackenzie-river-basin-initiative

Watershed Learning Resources

http://www.canadiangeographic.ca/watersheds/map/?path=english/
learning-resources-list

(Upper Elementary)

Lesson 1: Building a Basic Watershed Model

Background

Ponds, puddles, lakes and streams all have something in common. They are all a result of water in a **watershed** collecting. **Watersheds** channel water from various sources of water that all drain into a common collection site. **Watersheds** come in many different shapes and sizes, but all are separated by highly elevated landforms such as a ridge, hill or mountain. Water falling on each side of the elevated landform drains into different **watersheds** and collection sites.

Watersheds provide all of the water that we depend on. They provide drinking water, as well as water for people, plants, trees, animals, and even industrial processes. However, because all of the water in a **watershed** eventually flows into the same place, **watersheds** are very sensitive to **pollution**.

Everyone has a responsibility to ensure **watersheds** are in good health. Everyone's individual actions add up – both positive and negative.

*Additional background information about **watersheds**, their size, features and importance is included in pages 1 to 7.*

Activity Details

Objective:

Students will construct a basic watershed model to better understand what a watershed is and how it works.

Key Concepts:

Understanding watersheds and their general functionalities.

Duration:

Minimum of one 60-minute period, excluding extension activities.

Grade Level:

Mid to Upper elementary

Classroom Setup:

It is recommended that students work in groups of 3-5 people, although it is also possible to run as a class demonstration exercise.

Materials:

- Container to build watershed in *
- Scrap newspaper **
- One large white garbage bag (or aluminum foil)
- Tape
- Blue marker
- Spray bottle with water
- Blue food colouring
- Scissors
- Optional: a map showing NWT and the different sub-basins

** suggested containers include plastic Rubbermaid tubs or aluminum baking pans*

*** scrap newspaper pieces are suggested here to create elevation in the model: they can be substituted with other common materials such as styrofoam cups, empty pop cans, or other objects of various heights*

Preliminary Discussion Ideas

Lesson 1: Building a Basic Watershed

Begin by engaging students in a class discussion about **watersheds**. Some suggested questions include:

- What happens to rain water when it falls on the ground? Where does it go and where does it end up?
- What is the name of the largest River in the NWT?
- Where is the Mackenzie River (on a map for example)?
- What makes water move down a river? Or down a stream?
- Why does water flow down a hill and not up a hill?
- Does anyone know what a **watershed** is?
- Where is a local **watershed** in our community?
- Where does the water in our **watershed** come from?
- Has anyone heard about the **water cycle**?

Inform the class they will be learning about **watersheds** using a model, which is a simplified representation of real life.

Procedures

Lesson 1: Building a Basic Watershed Model

1. Divide the class into groups to work on the **watershed** model. Provide each group with a container to build their **watershed** model in. Otherwise, perform these procedures as a demonstration.

2. Ask students to crumple or roll up various pieces of scrap newspaper and place them in their model container (Photo 1). Explain that these will be used to create elevation in their model. It is ideal to have the newspaper form taller mounds around the outer edges of the container. This will ensure that the water will generally flow towards a central valley or collection point in the container.

Photo 1: Creating elevation with scrunched newspaper

3. Once the newspaper is positioned in the container, drape the white plastic garbage bag (or tinfoil) over the newspaper. Tape the garbage bag (or tinfoil) to the outer edges of the container to secure it in place (Photo 2).

Photo 2: Draping tinfoil over the watershed model

Lesson 1: Building a Basic Watershed Model

4. Ask the students to explain what they think will happen when it rains or snows on their model. Ask them to use a blue marker to draw where they think the rivers and streams will form and where the water will pool (Photos 3a & 3b).

Photo 3a & 3b: Using a blue marker to predict where the water will flow on the model

5. Fill the spray bottle with water, and a small amount of blue food colouring. Explain that the blue water will simulate rain. Gently and slowly spray some water over the model. Encourage the students to watch where the rainwater travels. Repeat the rain simulation process (Photo 4).

Photo 4: Simulating a rainfall event with spray bottle

Post-Activity Discussion

Lesson 1: Building a Basic Watershed Model

Assessment / Evaluation

After students have had a chance to build their **watershed** model and experiment with simulated rainfall, bring the class together to discuss their results. Some ideas for a post-activity discussion include:

- How did the water flow over the land? What patterns did you see?
- What happened to the water that fell on the land? Where did it end up?
- Did the water follow the same pathway as you predicted with the marker?
- Where did the water accumulate? Why?
- What did the high areas in your model represent?
- What direction did the water flow? What caused the water to flow that way?
- What roles do mountains play in a **watershed**? Streams? Rivers? Lakes?

There are many ways to check for student understanding of watersheds. Some options may include:

- Watershed Student Worksheet – have students answer the questions on the attached worksheet and hand it in for evaluation (page 21) .

- Wonderful Watershed Crossword – have students complete the attached "Wonderful Watershed Crossword" puzzle (page 22).

- Writing Exercise – have students write a short paragraph to explain the imaginary path of a water droplet from the time it hits the ground to the time it reaches a river and/or lake.

Lesson 1: Building a Basic Watershed Model

Extensions

- Interactive Online Mapping – have students go to the Canadian Geographic **watershed** information page to learn more about Canada's **watersheds** (http://www.canadiangeographic.ca/watersheds/map). Encourage students to find the **watershed** and sub-watershed that their community is located within. Have students identify and research which major river their water flows towards.

- Get Outside – take your students to a local nearby waterway, noting streams and tributaries along the way. Ask the students to look around at the shape of the surrounding landscape and discuss why the water is flowing or pooling the way it is.

- Make it Local – provide your students with a copy of a local map for your schools area. Encourage students to review the map and identify the nearest river system and **watershed** features, including hills, streams, rivers and lakes. **Topographic maps** in the Northwest Territories can be found at http://www.geomatics.gov.nt.ca. Local **source water** maps for all communities in the Northwest Territories are available through the Government of the Northwest Territories Centre for Geomatics at http://www.geomatics.gov.nt.ca/maps.aspx?i=8.

- Act it Out – for younger students, you may want to have them create and perform a **watershed** play. In small groups, students can act out the different roles and parts of the **watershed** to show how they are all connected. Some parts may include rain, rivers, streams, slopes, plants, animals, trees, **pollution**, lakes, etc. You can add more roles as the students become more familiar with the play.

Lesson 1: Building a Basic Watershed Model

Post-Activity Discussion

- Add **Pollution** – add a different colour of food colouring to the spray bottle to represent some sort of **pollution** or disturbance to the natural system. Spray the polluted water the same way you did with the simulated rain. Encourage students to observe how the **pollution** travels through the landscape and discuss how it compares to a real **watershed** (Photo 5). You may also want to try putting some sort of **pollution** directly on the land surface to demonstrate how a rain event can wash pollutants and other substances off the land and into nearby water bodies.

Photo 5: Experimenting with pollution

- Add Snow – Using snow in a sifter or colander, have students shake snow over the **watershed** model. Ask them to pay attention to where it collects and where it slides together on the model. Then ask them to add **pollution** (coloured water in spray bottles). The **pollution** will be "trapped" in the snow and then released as the snow melts. Encourage students to think about how snow often carries **pollution** that originated from very far away.

Watershed Student Worksheet

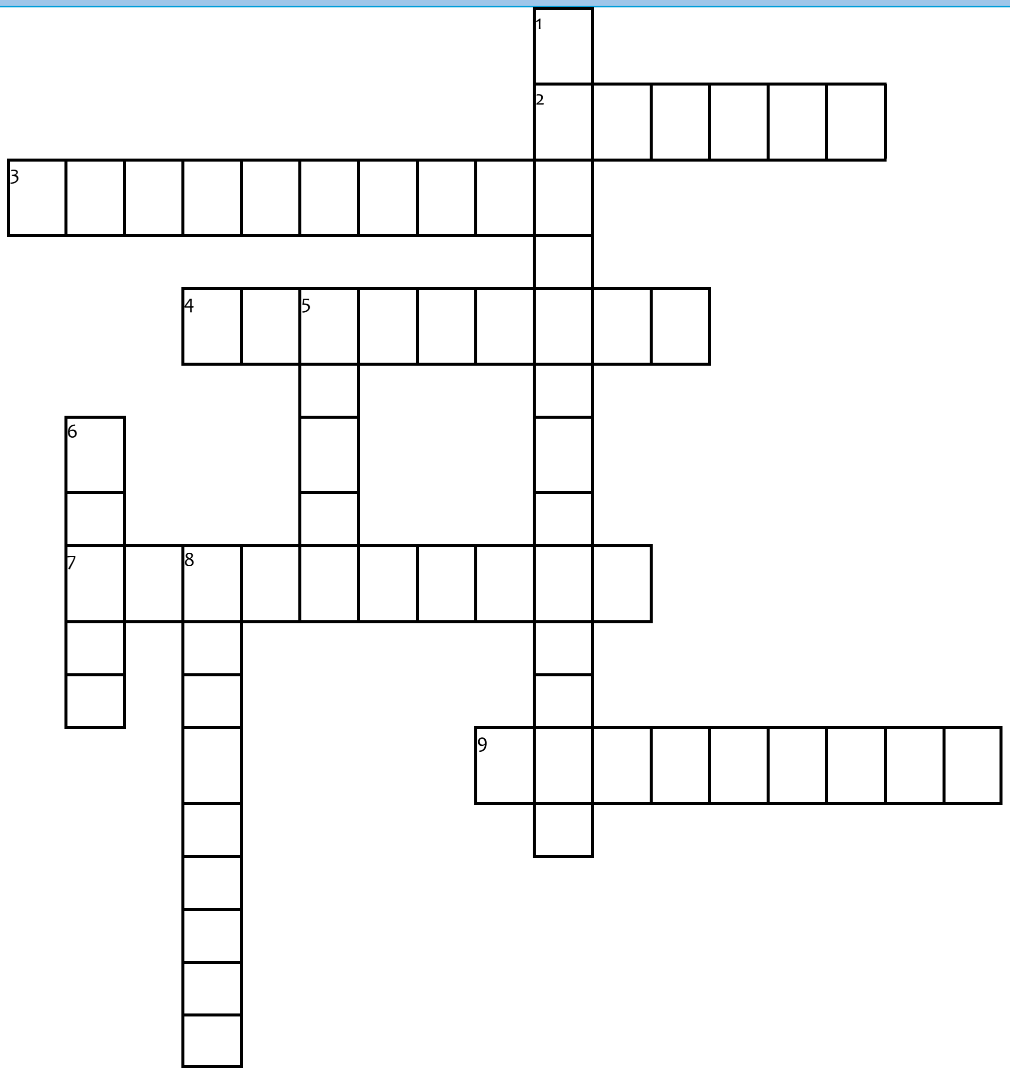
1. What does your watershed look like? *Use the box below to sketch your watershed model.*

2. What happened during the rainstorm? *Record what you saw when rain fell on the watershed model. Where did the water flow or pool?*

3. Why did the water flow or pool the way it did? *Explain why the water flowed or pooled the way it did in your model.*

4. What is a watershed? *In your own words, describe what a watershed is.*

Watershed Student Worksheet



Across

2. In a watershed, water can flow downhill to form these. They often join together in a watershed.

3. The name of the system that describes how water moves through the earth

4. When there is something harmful or poisonous in the water.

7. In a watershed, water flows in this direction

9. These are represented by the high areas in

Down

1. Rain, snow, hail and sleet are all examples of this.

5. In a watershed, these form when freshwater pools in the same area.

6. The name of the structure you built to represent a real life watershed.

8. An area of land that catches rain and drains into the same body of water.

(Middle School)

Lesson 2: Building and Experimenting with a Basic Watershed Model

Background

When the earth's surface is impermeable to water, meaning water cannot soak into it, excess water from rain or snow flows over the surface of the land as **surface run-off**. Overtime, this water flows downwards and eventually collects in channels such as rivers and streams. All the area of land that drains into one main lake or river is called a **watershed**.

Watersheds vary substantially in shape and size, but are all defined by areas of high elevation that act as boundaries. The direction and speed at which water flows through a **watershed** is dependent on the topography of the landscape.

As water moves downward through a **watershed**, it forms creeks, streams and rivers until it eventually reaches the same **body of water**, such as a lake or ocean. However, without a model or map the concept of a **watershed** can be difficult to describe in a classroom. This activity gives students an opportunity to make a simple **watershed** model to better understand what **watersheds** are and how they function.

*Additional background information about **watersheds,** the **water cycle** and water **pollution** in the Northwest Territories are provided in the background material section (pages 1-7).*

Activity Details

Objective:

Students will construct a permanent classroom **watershed** model to better understand how **watersheds** and their various features function.

Key Concepts:

Understanding **watersheds**, their features, functionality and interaction with **pollution.**

Duration:

Minimum of two 60-minute periods, excluding extension activities .

Grade Level:

Middle school

Classroom Setup:

It is recommended that students work in groups of 4-5 people, although it is also possible to run as a class project with students sharing different roles.

Materials:

- Container to build watershed*
- Spray bottle with water
- Blue food colouring
- Papier-mâché materials (newspaper strips dunked in a thick mixture of flour and water)
- Water resistant sealer
- White paint
- 5 to 10 rocks, ranging from 5 to 20 cm
- Plastic wrap or white garbage bag

* *suggested containers include plastic tubs or aluminum baking pans.*

Preliminary Discussion Ideas

Lesson 2: Building and Experimenting with a Basic Watershed Model

Begin by engaging students in a discussion about the features and functions of **watersheds**. Some suggested questions include:

- Can anyone explain what a **watershed** is? Provide examples.
- Where does the water in **watersheds** come from?
- Can anyone explain the main components and concepts of the **water cycle**?
    - ⇒ Encourage a discussion and explanation about the different parts of the **water cycle**. Major parts include include **precipitation, evaporation** and **transpiration**, **condensation** and **surface run-off**.
- What are the different options for where water can go once it rains?
    - ⇒ Encourage a discussion about **surface water run-off**, sub-**surface run-off**, infiltration, and vegetation up-take.
- What are the different ways that land and people can impact how water flows through a **watershed**?
    - ⇒ Encourage discussion about topography of the land, the type of climate, the type of land surface, and human activities.
- What types of threats are common to **watersheds**?
- What are the main types of water **pollution** that we experience in the Northwest Territories?

Lesson 2: Building and Experimenting with a Basic Watershed Model

1. Divide the class into groups to work on the **watershed** model. Provide each group with a container to build the **watershed** in. Otherwise, perform these procedures as a class project.

2. Ask students to place rocks in the **watershed** container. Explain that the rocks will be used to create different levels of elevation. It is ideal to have the larger rocks at one end of the container to ensure that the water will generally flow towards one end of the container.

3. Once the rocks are positioned, tightly cover the rocks and bottom of the container with the plastic wrap. Ensure that the plastic wrap is secured to the edges of the container.

4. Ask the students to apply the strips of papier-mâché to cover the base of the model and the rocks. Additional layers of papier-mâché will make the model sturdier (Photo 6).

Photo 6: Applying papier-mâché material to the base of the model

Lesson 2: Building and Experimenting with a Basic Watershed Model

5. Once the papier-mâché has dried (this may take several hours), coat the surface of the model with a mixture of waterproof sealant and white paint (Photo 7).

Photo 7: Coating the surface of the model with waterproof sealant and white paint

(Optional – students may want to paint their model before continuing by painting the landscape)

6. Ask students to sketch their model from a birds-eye view. Their sketch should include points to mark the areas of high and low elevation.

7. Using the model and student sketches, ask students to explain what they think will happen when it rains or snows on their model. Ask them to use a blue marker/pencil crayon to draw lines where they think the rivers and streams will form on their drawing. You can also ask them to draw circles where they think the water will pool on their drawing. Students can record their predictions on the back of their sketch.

Lesson 2: Building and Experimenting with a Basic Watershed Model

8. Fill the spray bottle with water, and a few drops of blue food colouring. Explain that the blue water will simulate rain. Gently and slowly spray some water over the model. Encourage the students to pay attention to where the rainwater travels. Repeat the rain simulate process.

9. After the rain simulation, have students use a different colour on their drawing to indicate the actual path that the water took. Also ask them to include some indication of where the water collected in their sketch.

Once students have built their model and have a general understanding of what **watersheds** are and how they work, you may want to consider additional experiments. There are many different experiments that can be run with the completed model to introduce new concepts such as permeability, snow melt, wetlands, and water **pollution**. Some suggestions include:

- **Permeable Surfaces** – Remind students that the papier-mâché surface is impermeable, meaning that water cannot penetrate it, and thus the water flows over it easily. In reality, **watersheds** also have permeable surfaces, such as soil and vegetation, which allow water to **infiltrate**. Tell students that they can use paper towel (or felt) to imitate permeable surfaces. Ask students to add paper towel to the surface of their model. Simulate rain with the spray bottle and encourage students to observe how the paper towel impacts the flow of water in the model. Discuss the role that vegetation plays in controlling **water flow** in real landscapes.

- **Add Snow** – Using snow in a sifter or colander, have students shake snow over the **watershed** model. Ask them to pay attention to where it collects and where it slides together on the model. Then ask them to add **pollution** (coloured water in spray bottles). The **pollution** will be "trapped" in the snow and then released as the snow melts. Encourage students to think about how snow often carries **pollution** that originated from very far away.

Procedures

Lesson 2: Building and Experimenting with a Basic Watershed Model

- **The Role of Wetlands –** Cut a sponge into strips and place them in low-lying areas of the model. Explain that the sponge strips are supposed to imitate wetland areas. Wetlands are important features in a **watershed** because they are the main link between land and water resources. They play an essential role in storing and filtering water. Once the sponge strips are placed on the model, simulate rain with the spray bottle and encourage students to observe what happens when the water comes in contact with the sponges. Compare these observations to the experiments when there were not any sponges in place and elaborate on the role of wetlands.

- **Pollution on the Landscape** – Sprinkle cocoa powder or juice crystals over the landscape of the model and explain that it represents some sort of **pollution** in the natural system. Simulate rain with the spray bottle until the cocoa powder or juice crystals flow through the model. Encourage students to observe how the **pollution** travels through the landscape and discuss how it compares to a real **watershed**. Start a discussion about different sources of **pollution** and how the **pollution** moves through **watersheds**. You may also want to consider discussing possible **pollution** solutions.

- **Wetlands and Pollution** – Discuss the role that wetlands play in **water quality.** Explain that wetlands filter out and absorb many pollutants from **surface water run-off** as it travels across the land. This is why wetlands are often called "natural filters". Cut a sponge into strips to represent wetlands. Place them in low-lying areas of the model. Sprinkle cocoa powder or juice crystals at a higher elevation than the sponge strips ("upstream" from the wetland). Simulate rain with the spray bottle until the **pollution** comes in contact with the sponge strips. Encourage students to observe how the **pollution** travels through the landscape and discuss how it interacts with the wetland. The wetland (sponge) should absorb or "filter" much of the colour from the "polluted" water. Ask the students to take a small slice of their sponge and examine it– do they find the **pollution** trapped inside? As a follow up, you may also want to ask students to do more research into the health of wetlands and the types of risks that they are commonly exposed to.

Assessment/Evaluation

Lesson 2: Building and Experimenting with a Basic Watershed Model

There are many ways to check for student understanding of watersheds after this activity. Some options may include:

- Experiment Summary – have students write a one-page summary of the experiment(s) performed, including their predictions, results and lessons learned.

- Watershed Sketch – ask students to make a poster or map of a **watershed** – either a made up watershed or a local watershed. Tell students that their poster or map must include the locations of different water bodies, arrows showing the direction of water flow in the watershed, wetlands, potential **pollution** sources and the direction of **pollution** flow.

- Reflect – have students reflect on what it means to be part of their local watershed, particularly in terms of how it differs from being a part of their local community. Have students describe how their actions in their watershed can impact surrounding waterways.

- Writing Exercise – have students write a short essay to describe the imaginary path of a water droplet from the time it hits the land to the time it reaches a lake. Ensure that students include a description of how the water droplet may pick up **pollution** along its journey and how it may be impacted by a wetland.

Extensions

Lesson 2: Building and Experimenting with a Basic Watershed Model

- Measure Up – run the wetlands experiment with more precise measurements to track how much water is retained by the wetland (sponges). Fill a plastic cup with water and mark the water level. Then pour the cup of water into a spray bottle and simulate rain on the watershed. Make sure you spray all of the water. Encourage students to watch how the water moves through the watershed. Capture all of the run-off water in the cup at the low-lying areas. Record the amount of water that moved through the watershed by pouring the collected water back in the cup. Mark the water level on the cup. Re-run the same experiment for a second time, but with the addition of sponges/paper towel to represent wetlands. Spray the same amount of water and observe how it is absorbed by the wetland-like surface. Again, return all of the standing water to the cup and compare water levels. This should demonstrate how wetlands absorb and retain water.

- Explore Northwest Territories Watersheds – provide students with a copy of the "Watersheds of the Northwest Territories" map (http://nwtwaterstewardship.enr.gov.nt.ca). Ask each student to chose a sub-watershed on the map that they will research and present additional factors about. Have them include information about its size, location, major rivers and tributaries, as well as any details about problems that the **watershed** may have because of **pollution** or human activity.

- Make it Real – take your students to a local nearby waterway, noting streams and tributaries along the way. Ask the students to look around at the shape of the surrounding landscape and discuss why the way is flowing or pooling the way it is. Ask students to think about any pollutants or disturbances that might impact the waterway.

(Junior High School)

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Background

There are several types of maps, all of which show different information and serve different purposes. **Topographic maps** summarize the three-dimensional topography of the earth's surface on a two-dimensional map using **contour lines**.

Topographic maps are important tools for studying the earth's surface, not only for geologists, but also for land use planners, hikers, paddlers, engineers, etc. They are also particularly useful when trying to find the boundaries of a **watershed**.

Watershed boundaries are usually defined by areas of high elevation, such as mountains or ridges that force water to flow in the same direction. Using a **topographic map** to find **watershed boundaries** for a creek or river is as simple as finding the highest points around the creek and connecting the points. Although **watersheds** are best studied by being in them, this activity provides students in the classroom with a more approachable perspective of **watersheds** by having them make simple models.

*For more background information on **topographic maps** go to the "What are Topographic Maps and How do they Relate to Watersheds?" section at the beginning of this guide (page 6). Additional background information about **watersheds**, their size, features and importance is included in pages 1-7.*

Activity Details

Objective:

Students will use **topographic maps** to determine watershed boundaries and features that they will then turn into a 3-D model.

Key Concepts:

Understanding **topographic maps** and how to delineate **watershed** boundaries from **topographic maps.**

Duration:

- Part 1: One 60-minute period
- Part 2: Varied depending on model making method selected – see procedure list

Grade Level:

Junior high school

Classroom Setup:

It is recommended that students work in groups of 3-5 people

Materials:

Reading a Topographic Map Worksheet (page 33) [optional]

Part 1:

- *Delineating Watersheds Worksheet (page 40)*
- Student copies of a topographic map
- Markers and/or highlighters
- Pens and pencils
- Rulers

Part 2:

Model making materials will depend on the type of model being built – see Part 2 Procedures for material list

Preliminary Discussion Ideas

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Begin the lesson by engaging students in a class discussion about **topographic maps**. Some suggested questions include:

- How do we represent three-dimensional landscapes on a map? What type of map does this?
- What is a **topographic map** is? What does it show? How does it work?
- What are **contour lines**? What do **contour lines** represent?
- What might a **topographic map** be used for? Provide some examples.

Depending on how familiar your students are with **topographic maps**, you may want to begin with the "*Reading a Topographic Map Worksheet*" (page 33) before beginning the main lesson procedure. You may also want to find and display a **topographic map** of your area (go to http://www.geomatics.gov.nt.ca for **topographic maps** in the Northwest Territories) to enhance student learning. Use the map as a teaching tool and encourage students to identify and interpret **contour lines** on the map.

Once students are comfortable working with **topographic maps,** you may want to briefly discuss **watersheds**. Some possible discussion questions include:

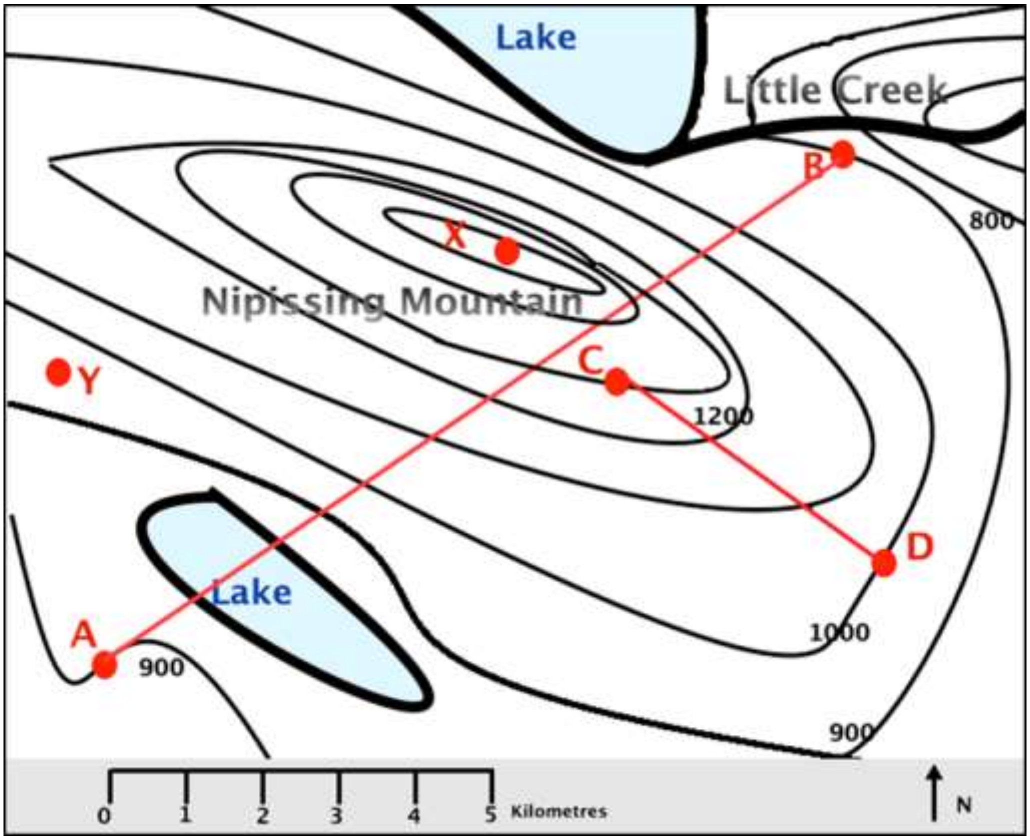
- What a **watershed** is? Provide examples.
- How does water flow through a **watershed**?
- How can **topographic maps** can help us identify **watersheds**?
- Can you name the local **watershed**?

Reading a Topographic Map Worksheet

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Topographic maps show elevation changes in an area. Although they are two-dimensional, topographic maps are able to represent three-dimensional landscapes through the use of contour lines. Contour lines are imaginary lines that connect points that are the same elevation on the land. Therefore, if you were to walk along a contour line, you would not go up or down - you would be walking along the same elevation. The contour interval refers to the elevation difference between contour lines.

Use the topographic map below to answer the following questions.



Reading a Topographic Map Worksheet

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

1. What is the elevation of point A? ______________________

2. What is the elevation of point B? ______________________

3. What is the elevation of point C? ______________________

4. What is the elevation of point D? ______________________

5. What is the contour interval of this map? How do you know?

____

____

6. In what direction does Little Creek Flow? *Explain how you know this.*

____

____

7. What is the elevation of point X? ______________________

8. What is the elevation of point Y? ______________________

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

9. What is the elevation of the highest point shown on the map?

10. Which side of Nipissing Mountain has the steepest slope? (*use the compass direction*)

11. If you were to walk along the red line that connects point A and point B, would you be walking uphill or downhill or both? *Explain how the elevation would change if you were to walk along the line.*

12. If you were to walk along the red line that connects point C and point D, would you be walking uphill or downhill or both? *Explain how the elevation would change if you were to walk along the line.*

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Procedures

1. Provide each student with a paper copy of a **topographic map**, preferably local to your school/community. Depending on your class size, you may want to have 3 or 4 different map versions so that students are working on different maps. Each map should have an easily identifiable "study river" for which students can delineate a **watershed boundary** around. For example, in Photo 8, the Toochinokla River (which is a tributary of the Keele River in the Northwest Territories) is the study river.

2. Ask students to locate their study river on the map and use a highlighter or thick marker to draw a line that follows the main channel of the river, from its headwaters to its outlet. It is also helpful to have students label the headwaters (H) and outlet (O) of the river.

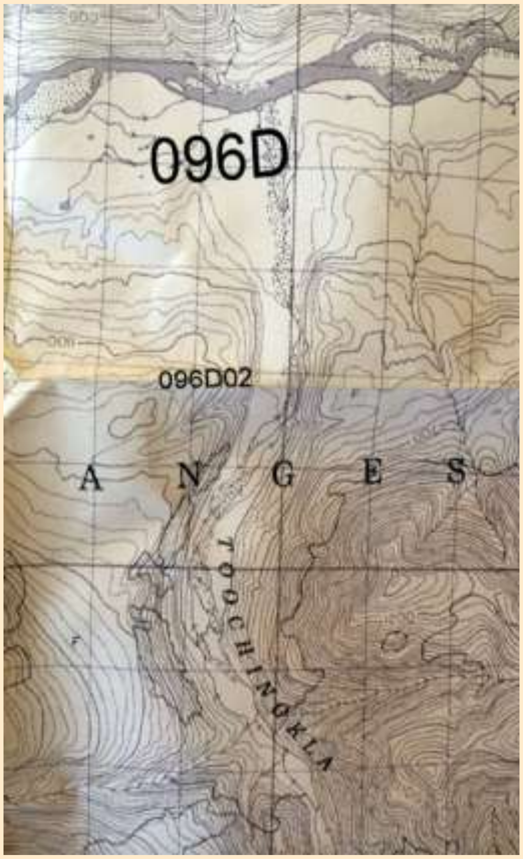


*Photo 8: Example **topographic map** and study river*

3. Next, have students divide their study river into approximately 1 cm intervals along the main channel of the river. The division between intervals should be marked with a short line at a right angle (perpendicular) to the study river (Photo 9).

Photo 9: Breaking the study river into 1 cm intervals

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

4. Starting at the headwaters of the river, ask students to follow each line that they drew upslope, away from the river, until they run into the highest elevation. Mark the highest elevation with an "x". Do this for both sides of the river. The "x's" illustrate the points of highest elevation surrounding the study river (Photo 10).

5. The next step is to connect the "x" marks together, trying to stay on the ridges or areas of high elevation. This line should always cross the **contour lines** at right angles. The result is a **watershed boundary** for the study river (Photo 11).

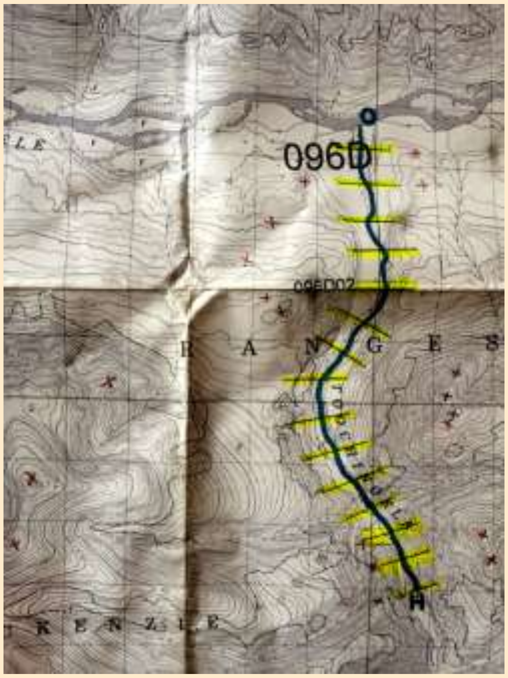


Photo 10: Marking areas of highest elevation surrounding the study river with an "x"

Photo 11: Connecting the areas of high elevation ("x's") to delineate the watershed boundary

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Assessment/Evaluation

- Have students hand in their **topographic maps** with their completed **watershed boundary**.
- Ask students to complete and hand in the "*Delineating Watersheds Worksheet*" (page 40).
- Have students present their **topographic map** and **watershed boundary** to the class. Ask them to explain how they created their boundary and what the boundary represents. Encourage students to compare their boundaries to one another and determine the similarities and differences.

Delineating Watersheds Worksheet

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

1. What does the boundary you created represent? *Briefly explain.*

2. What will happen to the rain that falls within the boundary you drew? *Why?*

3. What will happen to the rain that falls outside the boundary you drew? *Why?*

4. What is the highest elevation within the boundary?

5. What is the lowest elevation within the boundary?

6. Which direction does the study stream flow? How do you know?

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Procedures

1. Divide students into small groups – 3-4 people per group is ideal. If students have completed *Part 1 : Delineating a Watershed Boundary* and have created an accurate **watershed boundary**, students may want to use their existing **topographic map** and boundary to create their **watershed** model. Alternatively, you can provide each group with a paper copy of a **topographic map** and **watershed boundary** of your choice, preferably local to your community. For simplicity, you may want to choose a landform that is represented by a maximum of 7 contour levels. **Topographic maps** with a map scale of 1:24;000 are ideal for best results.

2. There are many different ways to make a **watershed** model based on a **topographic map**. Lesson 1 outlines a procedure for making a basic **watershed** model that can be done in less than an hour using tinfoil and newspaper. Lesson 2 provides a method for making a slightly more detailed and permanent **watershed** model that can be done in about 2 hours using papier-mâché and a waterproof sealant. Depending on the time and materials you have available, you may want to consider using one of the aforementioned methods to generally model the **topographic map**. However, steps 3a to 3k provide an alternative method for students to construct a **watershed** model from a **topographic map** using construction paper and styrofoam.

   In the case that you have more time, and a small group of dedicated students, you may want to use the model-making method laid out in steps 4a to 4k. The latter method is geared towards creating a more permanent, detailed and accurate **watershed** model, and requires basic power tools. It may be best if combined with a shop/construction class or an extra-curricular program activity.

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Regardless of the method and materials used to build the model, the objective is for students to use a **topographic map** as a reference for making a representative watershed model.

3. Topographic model making procedure using construction paper and styrofoam:

Time Required:

- Minimum of one and a half 60 minute periods

Materials:

- Coloured construction paper
- Scissors
- Glue
- Styrofoam sheet (or cardboard)
- Photocopy from a topographic map
- Plastic tub
- Tape
- Clear plastic wrap
- Spray bottle
- Blue food colouring
- Water

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Steps:

a. Provide students with an enlarged copy of an original **topographic map**. Have students place the photocopy on top of a piece of black construction paper.

b. Ask students to carefully cut along the contour line representing the lowest major elevation. This is the first level of the model, hence it should be labeled with a "1". Set aside.

c. Place the photocopy on top of another piece of construction paper (preferably a different colour). Ask students to carefully cut along the next contour line. This is the second level of the model, hence it should be labeled with a "2". Set aside.

d. Students should repeat this procedure until they have cut out all of the **contour lines**. If the **topographic map** selected has a number of tightly spaced **contour lines**, encourage students to cut along the index contours, which are those that are marked with the heaviest lines.

e. Once all of the contours are cut out, students are ready to build their model. Begin by taking the second layer (layer 2) and gluing styrofoam (or cardboard or foam layers/spacers) to the bottom of the construction paper cut out. The layers/spacers are designed to represent an increase in elevation between each contour line.

f. The next step is to glue layer 2 to the top of the first layer.

g. Steps e. and f. should be repeated with the rest of the layers. See Photo 12 for completed examples.

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

h. Once all of the layers have been stacked, they should be arranged in a way that reflects the landscape of the **topographic map**. Arrange the elevated areas within a catchment container (i.e., plastic tub) that the model will be built in. You may need to secure the elevated pieces to the base of the container using tape or glue. The container will act as the **watershed boundary** that will catch the water when it rains.

i. Drape the elevated pieces you created with snug plastic wrap. The plastic wrap simulates the land surface of the **watershed**.

j. Using the model, ask students to explain what they think will happen when it rains on their model. Encourage them to think about and discuss how the topography of the land will impact where the water flows.

k. After a short discussion, fill the spray bottle with water, and a few drops of blue food colouring. Explain that the blue water will simulate rain. Gently and slowly spray some water over the model. Encourage the students to pay attention to where the rainwater travels. Repeat the rain simulation process.

*Photo 12: Examples of elevated pieces created to represent **contour lines** on a **topographic map***

4. Permanent topographic model making procedure using basic construction and hardware tools:

Time Required:

- Minimum of 2 weeks

Materials:

- Two panels of high density styrofoam insulation sufficient for the dimensions of your model. These are usually available in 2' x 8' in thicknesses of 1", 1 ½", and 2".
- 1-2 cans of low expanding foam insulation
- 1 piece of strong translucent polythene sheeting
- A dremel tool or equivalent high detail rotary tool
- Carpenter's glue
- Dusk mask
- Sandpaper
- Marine grade silicone adhesive (ask the staff at the hardware store)
- PVA Glue or ordinary classroom white glue
- White primer paint
- Oil paints of various colours
- Polyurethane varnish

Steps:

a. Choose the **topographic map** of the exact area that you want to model and use it to make a template. Print a copy of the map in the dimensions of the model you want to build.

   While building part of the Yellowknife River Watershed model in Photo 13, we found that building a model with dimensions of 2' x 4' was advantageous because the insulation foam panels we planned to use were only available in dimensions 2' x 8'.

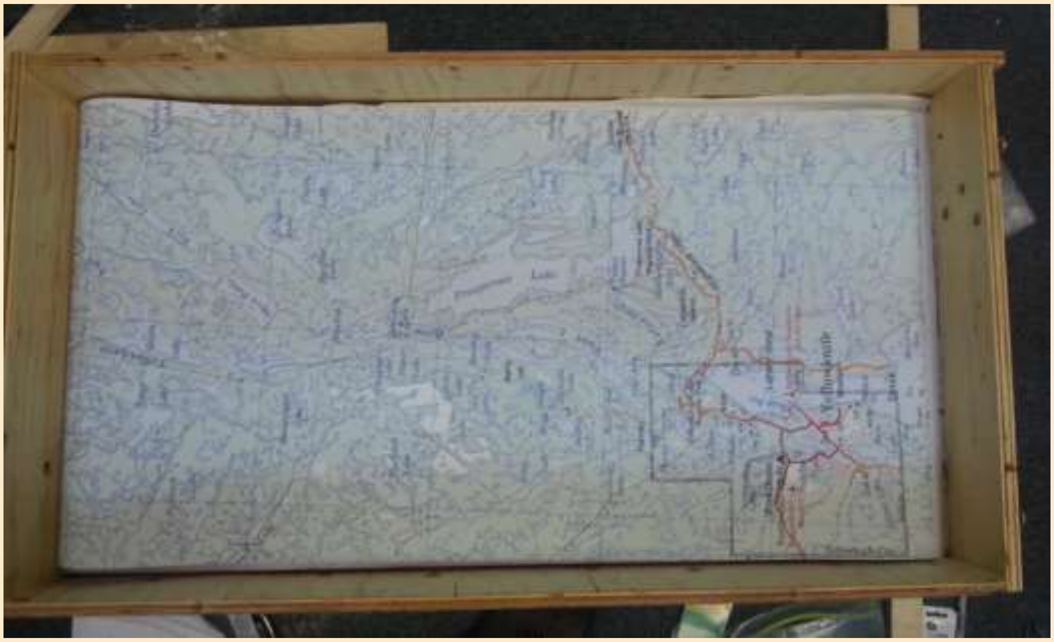


*Photo 13: Selected **topographic map** sitting on the bottom of the 2' x 4' box that will eventually house the model*

b. Cut your foam panel so that you have one piece that is of the same dimensions as your planned model. For the model shown in the example photos, this was a simple case of cutting a 2' x 8' panel in half. This will form the base layer of your model. Take your strong translucent polythene sheet, and cut it roughly to the model size using your base layer piece of foam as a guide (Photo 14).

Photo 14: Using the foam block as a guide for cutting the polythene sheet

c. Place your map on top of this piece of foam and secure it with sticky tack so that it can't slip easily. Next, place the polythene sheet over the map and secure it with several pins (Photo 15).

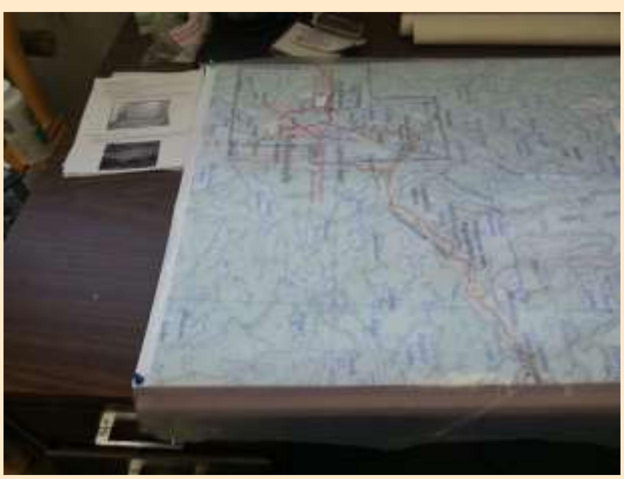


Photo 15: Topographic map and polythene sheet secured and ready for tracing

d. Now that your map and polythene sheet are securely in place, you can begin tracing your desired water features. Given that the Yellowknife River Watershed area is part of northern shield country, the **topographic map** in the example photos contained many small lakes and streams. In such a case like this, you may need to limit the model to only the main and predominant waterbodies (Photo 16).

Photo 16: Example of the Yellowknife River system and some nearby lakes traced and ready to be transferred onto the foam

e. Once you have traced the features, you will need to think about where water is going to flow in your model and how you are going to achieve this flow. In the case of the example area modeled, there is very little relief. This made it necessary to exaggerate the differences in elevation shown by the **contour lines** in order to ensure that experiments using the model would allow the water to flow.

In the case of the Yellowknife River, the river follows a very windy course. Consequently, simply tilting the model in the direction of flow was not an option. Alternatively, a 1" thick slab of high-density foam was used to create three different levels of elevation. (Photo 17)

Photo 17: Clockwise from top left: Marking out the proposed edges of the layers, cutting the template into three pieces, using the template pieces to cut the spare foam to size, the three layers of foam with their templates in place.

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

f. Once you have secured your template in place, it is time to start transferring the image directly onto the foam. In the example model this was done this by poking a pen nib through the template at very regular intervals along the lines and then joining the dots in the foam. This allowed us to use the template as a guide and potentially re-use the template if mistakes were made. It is important to keep at least one side of the template secured at all times (Photo 18).

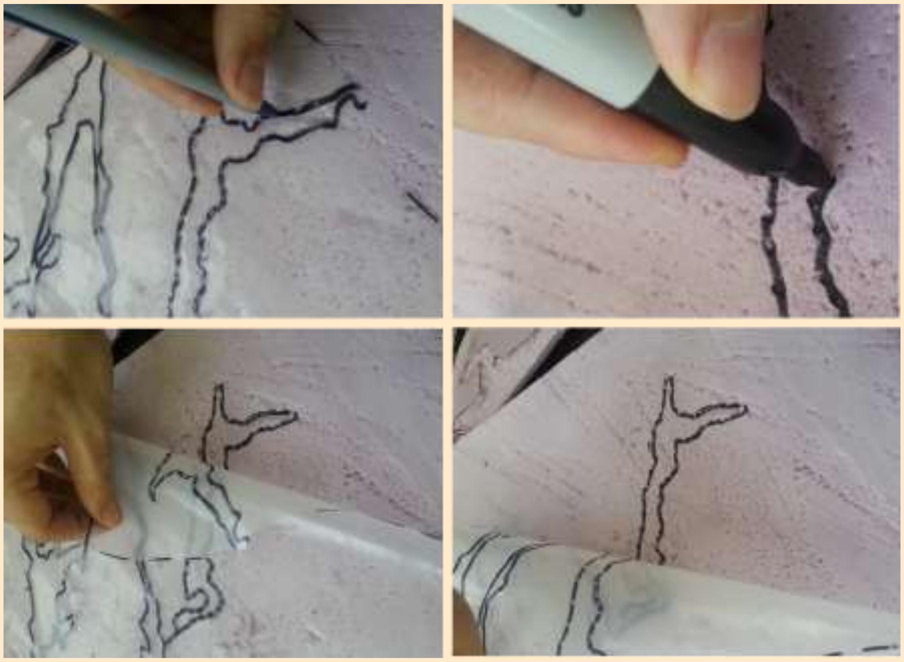


Photo 18: Clockwise from left: Poking holes through the template with a pen, joining the dots on the foam, checking the image on the foam against the image on the template.

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

g. Once you've completed this tedious but necessary process you are ready to start carving out the water features using a Dremel or detail rotary tool. However, before you start actually carving, it helpful to make sure that all your outlines on the different foam layers line up with each other. It's harder to fix errors once you have started cutting and carving.

For the example model, a bullet shaped grinding nib was used on the Dremel. This was effective because it cut through the foam quite easily without causing it to break away in chunks. It is recommended that you practice on a piece of scrap foam before getting started. Also make sure you wear a dust mask (Photo 19).

Photo 19: Left to right: Getting started carving out the lakes with the Dremel. Layers two and three with the lakes carved out and lined up with the base layer template. Note that we left room at the edges of the layers to create a gradient.

h. After carving out the lakes you may want to do a quick test to make sure that the water flows the way you intended. The next step is to add texture and build topography on the separate layers. In the case of the example model, super low expanding spray foam was used to re-create the texture of Canadian Shield (Photo 20). The foam needs to cure for about 6 hours before adding a second, more detailed application of spray foam (Photo 21).

Photo 20: The first application of spray foam once it had fully expanded and cured.

Photo 21: The second application of spray foam. This time the foam was spread around using scrap pieces of cardboard so that it would only expand a little. The image on the right is the end result.

i. The next step is to prepare the model for painting. It is important to prime the spray foam material with a substance that will adhere to the foam without corroding it. In the case of the example model, a finishing product designed to coat papier-mâché models was applied to the model surface (Photo 22).Once dry, this layer was covered with an acrylic primer (Photo 23).

Photo 22: Applying the coat of paper-Mache-finish

Photo 23: Applying the coat of primer

j. After the primer is dry, it is time to start painting. In the example model oil based paints were used. There’s no right way or wrong way to do this. In our model, the grey rocks were painted first, then the forest, and finally the lakes and the rivers (Photo 24). For extra detail you can brush model ink over the paint to create a shadow effect.

Photo 24: Clockwise from top left – Painting the grey, green and blue layers on the model. The complete model painted, inked and secured in the box.

k. The last step is to secure the model in the box. The edges of the model will need to be absolutely water tight with the inside of the box. This means that any gaps will need to be sealed with either marine grade silicone or expanding foam or both. In the example model the gaps were filled with expanding foam and marine grade silicone. The whole model will then need to be covered the with a thick coat of polyurethane varnish to make it absolutely waterproof (make sure your varnish is safe for use on foam. Some contain solvents that can eat away at foam).

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

Assessment/Evaluation

- Worksheets – both the *Reading A Topographic Map Worksheet* (page 33) and *Delineating Watersheds Worksheet* (page 40) can be used to assess students' knowledge of **topographic map** features and functions.

- Individual assessment – arrange class time so that students can be assessed individually based on their knowledge and understanding of **topographic maps** and **watersheds**. Provide each student with a **topographic map** different from the one they worked on for this lesson. Have each student go through the **watershed** delineation process described in part 1. You may also want to have each student verbally explain how water would flow through the **watershed** they delineated.

- Writing Exercise – have students write a short essay to describe the imaginary path of a water droplet from the time it hits the headwaters of their model to the time it reaches the outlet of their model. Ask them to clearly explain the role that topography plays in water flow.

Extensions

- **Watershed** Features – using toys and props ask students to simulate human settlements such as residential areas, roadways, recreation areas, and industrial activities. Try to replicate the different features that are found in your local area. The props do not have to be 100% representative of the **topographic map**, but they should encourage students to think of the model in terms of their geographic area and environmental surroundings.

- Model and Map Mix-Up – if you have multiple groups of students that created different **watershed** models based on different **topographic maps**, put all of the maps and completed models on display and encourage students to match the models to the correct **topographic map**.

- Model Demonstration – if you opted have your students build a more permanent **watershed** model (i.e., papier-mâché methods in lesson 2 or the step 4 method of this lesson) you can have your students present and explain how their model represents the **topographic map** area to their own class, a class of younger students, or a public audience. Encourage students to explain and show how water moves through their model. You may also want to ask each group to develop one experiment to simulate events that impact real landscapes, such as **pollution** transfer, erosion, or water uptake by wetlands. Other experiment examples are listed on page 57;.

- Role Play – assign your students different roles that represent different water users in their **watershed**. Ask each person with a role to describe why they need water and what they would use it for. As a group, determine which users are likely to be polluters. Where do the different types of **pollution** come from? Who is responsible for it? Have your students create a **watershed** management and clean-up plan for their **watershed**.

Lesson 3: Topographic Maps, Watershed Boundaries and Watershed Models

- Experiment Mania – there are many different experiments that can be run with a more permanent style model structure. These include:

  ⇒ Permeable Surfaces – Remind students that the model surface is impermeable, meaning that the water cannot penetrate it, and thus flows over it easily. Explain that in reality, **watersheds** also have permeable surfaces, such as soil and vegetation, which allow water to **infiltrate**. Tell students that they will use paper towel or felt to imitate permeable surfaces. Ask students to add paper towels and/or felt to their models. Simulate rain with the spray bottle and encourage students to observe how the paper towels impact **water flow**. Discuss how vegetation plays an important role in controlling the flow of water.

  ⇒ Role of Wetlands – Cut a sponge into three of four strips and place them in low-lying areas of the model. Explain to students that the sponge strips are supposed to imitate wetland areas. Wetlands are important features in **watersheds** because they are the main link between land and water resources. For this reason they play an essential role in storing and filtering water. Once the sponge strips are placed, simulate rain with the spray bottle and encourage students to observe what happens when the water comes in contact with the sponges. Compare these observations to the experiments when there were not any sponges in place.

  ⇒ **Pollution** on the Landscape – Sprinkle cocoa powder or juice crystals over the landscape of the model and explain that it represents some sort of **pollution** or disturbance to the natural system. Simulate rain with the spray bottle until the **pollution** flows through the model. Encourage students to observe how the **pollution** travels through the landscape and discuss how it compares to a real **watershed**. Begin a discussion about different sources of **pollution** on the land and how the **pollution** moves through **watersheds**. You may also want to consider discussing potential **pollution** solutions.

This is an education product developed in support of the Northern Voices, Northern Waters: NWT Water Stewardship Strategy. Produced and written by Ecology North with support from the Environment and Natural Resources Department, Government of the Northwest Territories.

For more information on water stewardship in the NWT, visit www.nwtwaterstewardship.ca.

Ecology North is a charitable, non-profit organization formed in 1971 to support sound environmental decision-making on an individual, community and level.

Through education, research and project facilitation, Ecology North works with communities throughout the Northwest Territories on topics related to water stewardship, food sustainability, waste reduction, and climate change adaptation and mitigation.

More information about Ecology North can be found at www.ecologynorth.ca.

Photo Credits

i Zumbro Watershed Partnership 2005: http://www.zumbrowatershed.org

ii WWF 2011: http://awsassets.wwf.ca

iii Water For Life Alberta: http://www.waterforlife.alberta.ca

iv Concept Draw: http://www.conceptdraw.com

v Pennsylvania Source Water Protection: http://www.sourcewaterpa.org

vi GNWT Centre for Geomatics: http://www.geomatics.gov.nt.ca

First printed in 2015.

Reprinted in 2020 with support from the NSERC PromoScience Program.