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...in the classroom

Experiential Science 30: Disturbance and Development

Indigenous Knowledge Lesson Plan

Local and Traditional Knowledge in Watershed Governance
www.trackingchange.ca

Experiential Science 30: Disturbance and Development

Purpose

Resource development, largely through mining, is a major part of the Northwest Territories' economy. Industrial activity has advantages and disadvantages. Understanding these impacts is important when making decisions about approving projects and identifying ways to mitigate the negative effects. This lesson exposes students to resource development projects in the Northwest Territories, introduces how Indigenous knowledge and local communities contribute to understanding of toxins, and allows students to investigate impacts of development in their local area.

UNIT 4: RESOURCE MANAGEMENT

Focusing Questions: How can freshwater resources be managed to ensure a sustainable future for generations to come?

- Students will gain an understanding of contaminants in freshwater by:
  - Investigating the sources of man-made contaminants.
  - Illustrating and describing the effects of bioaccumulation of man-made contaminants in an aquatic environment.
  - Researching and presenting, the historical perspective of the effects/ concerns of bioaccumulation of toxin(s) in your region.
  - Discussing the pros and cons of industrial development in an environmentally sensitive watershed including:
    i. Possible toxins
    ii. Biodegradation of toxins
    iii. Bioaccumulation
    iv. Environmental health issues
    v. Aquatic management concerns
    vi. Long and short term economic benefits to the community

Teacher Resources

- "Seeing nature through Indigenous 'lens' might improve environmental decision-making": https://www.cbc.ca/radio/seeing-nature-through-indigenous-lens-might-improve-environmental-decision-making-1.5645215

Cover Photo: Canoe on Sparrow Lake Sahtu Region
Photo Credit: Julien Schroder

- "Diamond Facts". (2020). Natural Resources Canada. https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/diamond-facts/20513
- "Gold Facts". (2020). Natural Resources Canada. https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/gold-facts/20514
- "Mining Facts". (2019). Mining Association of Canada. https://mining.ca/resources/mining-facts/
- "Electricity Facts". (2019). Natural Resources Canada. https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/electricity-facts/20068
- "Report: Hydropower essential to Canadian economy". (2015). Hydro Review. https://www.hydroreview.com/2015/05/14/report-hydropower-essential-to-canadian-economy/#gref
- "Zone Rate System". (2014a). Northwest Territories Power Corporation. https://www.ntpc.com/our-community/zone-rate-system
- "Hydro". (2014b). Northwest Territories Power Corporation. https://www.ntpc.com/smart-energy/how-we-supply-power/hydro
- "Greenhouse Gas Emissions and Reservoirs". (2020). Hydro Quebec. https://www.hydroquebec.com/sustainable-development/specialized-documentation/ghg-reservoir.html
- Mackenzie River Basin (location and introduction): http://www.trackingchange.ca/river-basins/mackenzie/
- This lesson is based on research from Tracking Change: Local and Traditional Knowledge in Watershed Governance: http://www.trackingchange.ca/.

Materials Needed:

- Computer and projector to play "Ice Diamonds" [9:39] about Rio Tinto's Diavik Diamond mine.
- Copies of case studies
    - Tracking Change: Mining Case Study
    - Tracking Change: Hydroelectric Damming Case Study
- Copies of Information Organizer Table
- Copies of "How to Conduct an Interview" (as necessary)
- Copies of "Disturbance and Development: Presentation Guidelines" handout
- [Optional] Presentation Assessment Rubric

INTRODUCTION

Industrial development can be important for economic development, but it also poses serious threats to the environment. For instance, chemicals used in mining can enter waterways. This lesson will introduce students to environmental disturbances that can arise from development. Students will be challenged to apply their learning to investigate a local issue using primary and secondary research, and then convey what they learned in a creative way.

Key questions for student inquiry:

- How do development projects impact my community? What is my community doing to address the issue?

LESSON PLAN PROPER

- **Location:** In classroom and in the school/community (interviews)
- **Length of activity:** 180-225 minutes / 4-5 class periods
- **Activating Strategies:**
  - *Introduction.* Briefly explain that resource development is widespread in the Northwest Territories. Watch the video "Ice Diamonds" [9:39] about Rio Tinto's Diavik Diamond mine. Discuss student reactions to the mining process and landscape. How do you think operations may affect the wildlife? The people? What are the benefits and drawbacks of industrial development?
    - https://www.youtube.com/watch?v=wiiID15zr_Q
- As a class, brainstorm economic, environmental, social, and cultural impacts of developments like mines and hydroelectric dams, including the pros and cons. Ask students to share the sources of information or experiences that contributed to their understanding (e.g. family members work for a mine; dams caused low water levels that disrupted a family fishing trip).
- On the board or a piece of poster paper create a chart to display the pros and cons of resource/hydroelectric development as it relates to environmental, socio-cultural, and economic factors. Option: display this poster throughout the remainder of the lesson as a frame of reference for considering other issues.
- **Learning Experiences:**
  - *Class Activity.* Provide students with copies of the attached case studies. Ask students to glance at the case studies and select the topic they find most interesting. Give students time to read the case study and prepare written responses to the following questions about the case study they selected. Responses may be collected for assessment. The case study worksheet included in the class materials can be used to guide student learning.
    - What was the motivation behind the development? What are the sources of the contamination or disturbance to the environment, as a result of the project?
    - How might the disturbances impact the water and wildlife? Describe the effect of bioaccumulation on the environment near the development.
    - What different perspectives do people have about the development?

- What does Indigenous knowledge have to say about how contaminants and disturbances impact fish and water? How might Indigenous knowledge be useful in making a decision about/managing the issue?

INDIGENOUS LANGUAGES - WORD BANK

Indigenous knowledge of the land is interwoven with language. The following are key terms in northern languages that are directly related to this lesson. Following the NWT's whole-school approach to language learning, we recommend bringing these terms into the science classroom, according to the language(s) spoken in your community. In this way, it is possible to provide students with a holistic understanding of the land, language, and culture in ways that support their own identities.

> *To use any of the Northern Indigenous languages fluently means that the speaker observes and interacts with their environment. They are relational languages. The connection between the speaker, their actions and the environment speaks to a worldview where relationships are important – relationships with self, others, the land and one's spirituality* - Our Languages, 2020, p. 5

We encourage collaboration with language teachers where available to support student learning. A few ideas to bring northern languages into science classrooms include:

- Creating classroom displays that highlight terms from this list using diagrams, photographs, artwork, and/or definitions.
- As a teacher, using these words in conjunction with or in place of English words throughout the lesson (and others) where possible.
- Encouraging students to incorporate these terms into written and oral components of this lesson (and others).
- Discussing with students how the precision of some of these words is linked with Indigenous knowledge of the land.
- Incorporating terms into a game/activity/lab assignment to make language learning fun.

Source: https://www.ece.gov.nt.ca/sites/ece/files/resources/our_languages_curriculum_2020_low_res.pdf

TRADITIONAL WORDS					
English	**Tsaat'ine tthadeh/ Dene (Beaver or xe'ghont'e)**	**Sahtúǫt'ıne/ Dene (Slavey or Kaguntu)**	**Nēhiyawēwin/ Cree**	**Dinjii Zhu' Ginjik/ Gwich'in**	**Inuvialuktun/ Inuvialuit**

Water level is rising	Tu tadeļı	Tu dieh adde'	wîtimîhk nîpîy, iskipew	Chuu dàk t'idi'inh	Imaq qag-vaqtuaq
Water levels	Tu dende'ǫ	Nde'ǫ gotsi tu	tânimây-kohk nîpîy	Chuu nijin nyaa'àih	Imaq naqittuq (low)
No more water	Tu eduļı	Tu nedu'e	meschi-payew nîpîy	Chuu kwàh	Makaituq imaq
Dried Up Stream	Sageh wogǫ'	Deh goh'gǫ	Pastew Sîpîsis	Teechik tachit-hitroh	Kuugaq taima-qtuaq
Dirty water	Tu tsene'	Tu dzǫ t'ehi	wîpahtan nîpîy	Chuu vee	Imaq salu-maittuq
Water that is muddy from industrial activity	Tu dek'odłeh woļı atse'lehi tsi'	Tu gócłeh gụnli woli atselihi tsi	wîpahtan nîpîy oschi atoskewnihk	Gwitr'it k'iighè' chuu dhiveh	Imaq salu-maittuq
Unhealthy fish	ługe edu uujǫ xedii	łue nezu'ile	mâyima-chihow kinosêw	Łuk ełts'ik	Iqaluk
Fish that is contaminated	ługe mbeta woli atiin	łue beta dzont'e	apiscipô kinosêw	Ejiich'ii iizuu k'iighè' łuk tagwin-iindhat	Iqaluk

These are some traditional words related to sustainability of freshwater ecosystems and fish. As you complete the lesson, encourage students to think about other words they would like to know the traditional word for. Who can they speak to to learn these traditional words?

Keywords: pollution; water scarcity

Themes: resource development; traditional knowledge; community monitoring

Student Handout: Mining Case Study

WHAT IS MINING?

Mining is the extraction of valuable minerals or other geological materials from the earth such as metals, precious gems, coal, gravel, and more. Mining also includes the extraction of non-renewable resources such as petroleum and natural gas. Mining is a human activity that is a large part of both our history and our current life.

While mining is necessary to how our current society functions, it also has some *disadvantages*. It impacts local ecosystems and causes major environmental issues, such as water pollution. Mines impact the health of the fish and wildlife near the mines and connected waterways, which is an issue for many Indigenous communities who rely on the fish and wildlife for food.

HOW DOES IT IMPACT US?

Mining has a long history in the Northwest Territories. There are gold, zinc, and diamond mines like the Diavik and Ekati that are still active. However, there are also many abandoned mines throughout the north, such as the Giant Mine outside the City of Yellowknife, which continue to leach toxins into the environment. Both active and abandoned mines have raised some concerns about the different impacts on the environment. The people most concerned about the environmental impacts caused by abandoned mines and mining development are those who live on the land and see the changes the most: Indigenous Elders, land users and harvesters, and other community members. After years living on the land hunting, fishing, and harvesting, they know the land the best. These people have vast amounts of knowledge and wisdom about the environment.

KEY DEFINITIONS:

MINING: The extraction of valuable minerals or other geological materials from the earth such as metals, precious gems, coal, gravel, and more.

BIOACCUMULATION: process by which substances, particularly contaminants, accumulate in a living organism over time. The substance is often stored in the organism's fatty tissue.

ENVIRONMENTAL HEALTH: focuses on the interrelationships between people and their environments. It includes all abiotic and biotic factors that are needed to sustain life. The "environment" part of the term includes both the natural environment and spaces made by humans.

SEISMIC TESTING: when shock waves or dynamite explosions are used to understand what is just below the surface of the earth (subsurface). It is used to help find the best places to drill for oil and gas.

Old Giant Mine Headframe - Yellowknife, NWT
Photo Credit: David Dyet

QUESTIONS TO CONSIDER:

Below are some statements from Elders, land users, and community members about some of the concerns they have about the impacts of mining on the environment. Information about mining processes is also included. As you read the case study, consider the following questions:

1. What are some possible toxins associated with the development?
2. Where might these toxins come from?
3. What are some potential environmental health issues associated with mining?
4. What aquatic management concerns exist about this development? What stakeholders are involved in aquatic management? What factors do these stakeholders consider and prioritize when making decisions about mining?
5. How do communities benefit from the development in long and short terms?

DID YOU KNOW?

There are approximately 25 mines located throughout the Northwest Territories. However, only four mines are actively still operating: **Snap Lake Mine, Giant Mine, Ekati Mine, and Diavik Mine.**

INDIGENOUS KNOWLEDGE ABOUT MINING

The draining of lakes and rerouting of ground water as a result of diamond mining activity is a major concern. The Gahcho Kue Diamond Mine is less than 100 kms from the community of Lutsel K'e. The diamond mine affects both the Artillery Lake and Lockhart River, as it is located in the Lockhart River system.

> *...it's hard to get by sometimes. We aren't miners, we're bush people. It's really scary. What's happening at the mines. I know they say it's okay, it won't affect the environment, but when they're gone we're going to have to deal with it. I don't know what's going to happen there.* - Joseph Catholique, Lutsel k'e area, p. 51, 2016-2017 Report

The Yellowknives Dene First Nations have been deeply involved in various kinds of research initiatives and consultations regarding the impacts of this mine on their health, culture, and livelihood. Their involvement and understanding of potential mining impacts has made people concerned about mining in other areas.

> In general, it is believed that where there are mines the fish are unhealthy and *where there are no mines the fish are healthy* - Yellowknives Dene First Nation Elder, Akaitcho area report, p. 54, 2016-2017 Report

Similar to concerns raised about mining in the north, in the 70s, 80s and 90s in the Dehcho area seismic testing was done that was detrimental to the fish population along the Mackenzie river. What someone from the community had to say on this issue:

> *A tugboat pushing three or fours barges would stop every kilometre or so and set off an explosion—blasting. Each blast sent water shooting up above the trees. There were many dead fish floating down the river.* - Dehcho K'ehodi Program participant, Dehcho area, p. 36, 2016-2017 report

Giant Mine Remidiation Project
Photo Credit: Kevin O'Reilly

MINING PROCESSES

Mining Diamonds (Adapted from: https://www.shimansky.co.za/discover/about-diamonds/mining)

Diamonds are usually found in a rock called "Kimberlite." There are several ways to mine diamonds from Kimberlite: open-pit mining, underground mining, and alluvial mining.

- **Open-Pit mining** involves removing layers of ground material just above Kimberlite rock. Next, explosives are used to break up the rock and the broken "ore" is transported to machinery to be processed.
- **Underground mining** is when miners tunnel through the Earth's crust to reach the Kimberlite. Two tunnels are built - one over the other - with funnels built to connect the two. Miners blast ore in the top tunnel which then falls and collects in the second tunnel. Loaders then collect the broken Kimberlite and transport it to the surface for processing.
- **Alluvial mining** is focused on extracting diamonds from Kimberlite that has been transported down streams and rivers. Over thousands of years the Kimberlite that reaches the surface has been eroded, and alluvial mining utilizes these downstream deposits. Diamonds are usually found in the gravel of layers of mud, clay, and underwater plant life. Large-scale mining involves diverting water behind a large wall and then collecting and hauling the Kimberlite material to a processing area.

FACTS ABOUT MINING IN CANADA:

In 2018, Canada was the world's third largest producer of diamonds (NRCAN, 2020)

In 2018, Canada's total primary exports of diamonds were valued at $2.9 billion (NRCAN, 2020)

Gold is a precious metal and is most commonly used in jewellery. About 40% of gold is purchased by banks and investors for investment and financial stability purposes. Gold is Canada's most valuable mined mineral and is extracted in nin Canadian provinces and territories. Unlike diamonds, gold is continualling being recycled. Gold can be melted down and used again!

NWT MIning Trolley
Photo Credit: James Carmichael

There are 5 steps needed to process the Kimberlite ore and extract diamonds.

1. **Crushing:** Large pieces of ore are crushed into small pieces, no more than 150mm. Another crusher is used to break down to even smaller pieces.
2. **Scrubbing:** Pieces of ore are scrubbed down to remove loose material, like sand, and then screened to ensure they are the correct size. Pieces of ore smaller than 1.5mm are discarded because it is too expensive to remove diamonds from such a small rock.
3. **Cyclonic Separation Plant:** A chemical solution of ferrosilicon powder and water is combined and mixed with the diamond-bearing ore. The mixture is then put into a cyclone machine where it is tumbled. The material with the highest density sinks to the bottom of the machine, and the less dense diamonds form a layer at the top.
4. **Recovery:** The diamond concentrate then goes through several processes that involve magnetic susceptibility, x-ray luminescence, and crystallographic laser fluorescence (science of determining the arrangement of atoms within crystals). The exact processes are decided on based on the unique properties of the diamonds, in order to separate the diamonds from other materials. Sensors detect flashes of light emitted by the diamonds and a microprocessor blasts air at the diamond which is spit into a collection box.
5. **Cleaned, Weighted, and Packaged:** Diamonds are removed from the collection box and cleaned with an acidic solution. The final stage is washing, weighing, and packaging diamonds for transportation.

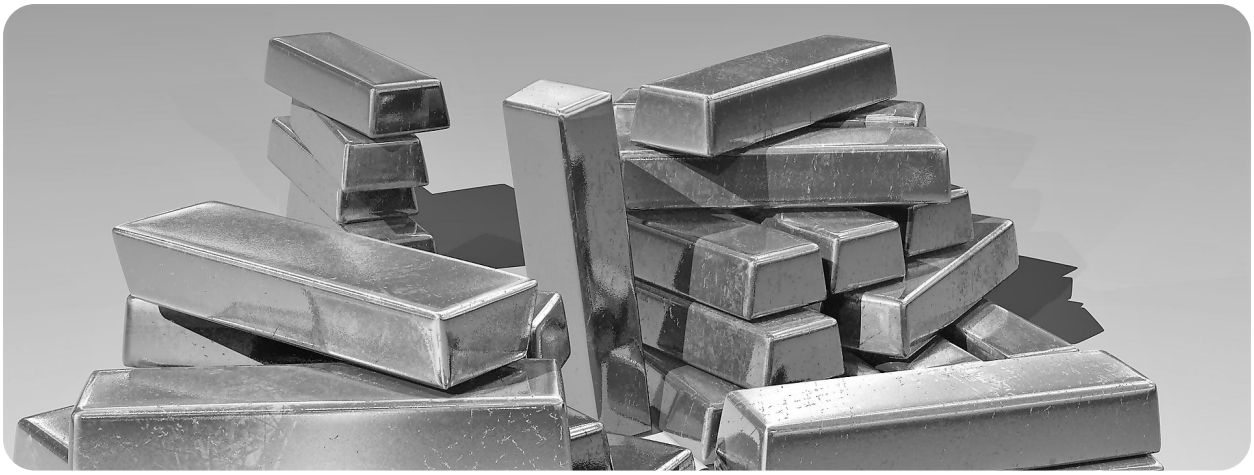
Figure 1: 5-Steps needed to process Kimberlite Ore and extract diamonds.

Extracting Gold

(adapted from: https://science.howstuffworks.com/gold4.htm)

Removing gold-bearing rock material from the ground is the first step in gold mining. Next, mining companies use a complicated process to extract gold from the material.

1. **Crushing:** Miners break down large pieces of rock into smaller pieces. "Crusher" machines break the rock down into sizes about the size of road gravel. This material is then put into rotating drums along with steel balls. This process grinds up the rock and turns it into a slurry or powder.
2. **Leaching:** The slurry or powder is mixed with water to form a pulp. This mixture is put into leaching tanks where the gold is dissolved out of the rock using a chemical solvent. Most often, miners use cyanide in this process. When cyanide is used it is combined with oxygen in a process known as "carbon-in-pulp." The chemical reaction of cyanide and oxygen interacting causes the gold to dissolve. Miners insert filters which helps in separating the gold-bearing carbon from other materials.
3. **Stripping:** The gold-bearing carbon is moved to a stripping vessel where a hot, corrosive solution separates the gold from the carbon. More filters are used to remove the carbon grains, which can be recycled for future gold extraction. Next, the gold-bearing solution enters the electrowinning stage which recovers the gold from the leaching chemicals. This happens when miners pour the gold solution into a container known as a "cell" and strong electric currents are used to remove the gold.
4. **Smelting:** This stage results in nearly pure gold. The remaining gold material is put into a furnace at 2,100 degrees F (1,149 degrees C). A chemical mixture called "flux" is added to the molten material which separates gold from any remaining non-gold material. Molds are used to transform the liquid into gold bars. Low-purity bars are sent to other refineries for future processing.



Bricks of Gold
Photo Credit: Steve Bidmead

Aerial View of an Open-Pit Mine
Photo Credit: Dion Beetson

ENVIRONMENTAL IMPACTS

In general, mining can pollute water and air, disrupt wildlife, and permanently change natural environmental systems. Chemicals used while processing diamonds and extracting gold can leak into bedrock or nearby waterways. This results in poisoned water, as well as fish and other species that bioaccumulate toxins overtime. People that rely on food harvested from the land are at risk of consuming the chemicals either through drinking the water or consuming animals that have the toxins stored in their body tissues. This can cause serious health problems. Industrial developments also require large amounts of water, which can result in changes to the waterways natural flow and water levels.

Roadways built to support industrial development can result in wildlife habitat degradation and fragmentation. Degradation happens when humans convert natural areas into landscapes like cropland, urban centres, or areas for infrastructure (e.g. roads, dams, powerlines). Habitat fragmentation happens when an animal's habitat is cut into smaller pieces due to human development. If fragmentation occurs it means an animal may no longer have access to enough space to access the food, water, and shelter it needs. Wildlife also face dangers of being struck by machinery or vehicles, or being "destroyed" if they get too close to human settlements. Caribou, wolverine, bears, ptarmigan, and fish, are some of the animals that are the most impacted by mines

ECONONOMIC CONSIDERATIONS

Many people think diamonds are only used for jewellery. However, 80% of the world's diamond production (by weight) is used in industrial and research applications. Diamonds are also used to dissipate heat in electronic devices. This is because diamonds have the highest thermal conductivity of any material at room temperature. Next time you use a cell phone or computer, think about the role a diamond plays in its operation!

Student Handout: Mining Case Study Worksheet

NAME _____ **DATE** _____

Determine if the following statements are true or false:

_____ 1. The 5 steps needed to process Kimberlite ore and extract diamonds are crushing, scrubbing, cyclonic seperation, recovery, and cleaning,weighting, and packaging.

_____ 2. Bioaccumulation is the process by which substances, particularly contaminants, accumumalte in a living organism over time.

_____ 3. Mining does not include the extraction of non-renewable resources.

_____ 4. In the 70s, 80s, and 90s, seismic testing was done in the Decho region that was detrimental to fish populations in the area.

5. In your own words, describe the concept of “environmental health”:

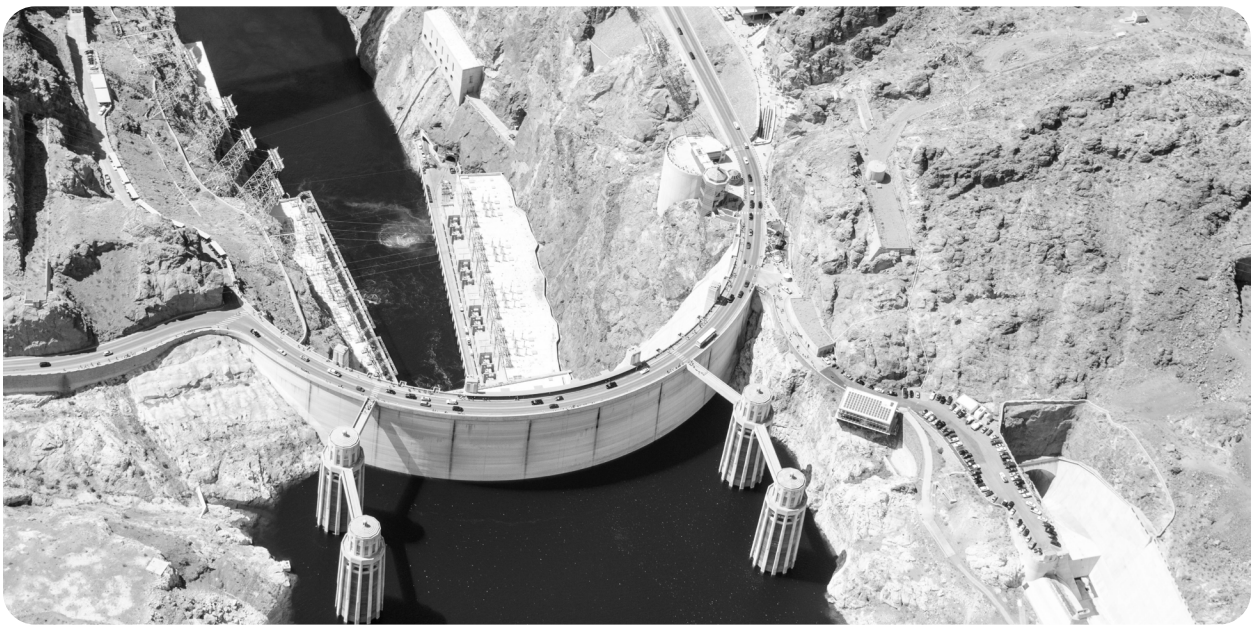
6. What are some of the disadvantages of Mining?

Student Handout: Hydroelectric Damming Case Study

WHAT ARE HYDROELECTRIC DAMS?

Hydro dams are a great source for renewable energy in regions where water is plentiful. They use the force of running water to generate energy through dams across rivers. Hydropower is a replacement for harmful fossil fuels that contribute to climate change, positively impacting the health of the planet. Hydro dams do not release pollutants into the air, meaning the air around them remains clean to breathe.

However, hydro damming has significant environmental impacts on local ecosystems. Hydro damming blocks fish migrations, traps sediments upstream that are important to downstream ecosystems, and keeps Indigenous peoples from accessing some of their traditional fishing areas.



Areal Image of a Hydroelectic Dam
Photo Credit: Cédric Dhaenens

DID YOU KNOW?

The **Tracking Change** research project identified that fish in the area around Nonacho Lake are considered 'ruined' due to the impacts of the **Talston River Hydroelectric Project.** The flooding that occurred as a result of that project led to changes in **mercury** levels in fish as well as other changes in the quality of fish tissue such that people no longer consider them good to eat. This is consistent with other environmental impacts when dams are built on free-flowing water, including **changes in temperature, chemical composition, and dissolved oxygen levels.**

KEY DEFINITIONS:

ENVIRONMENTAL HEALTH: The concept of "environmental health" focuses on the interrelationships between people and their environments. It includes all abiotic and biotic factors that are needed to sustain life. The "environment" part of the term includes both the natural environment and spaces made by humans.

MERCURY: Mercury is a naturally occurring element that is toxic to humans, causing serious health problems. People are mainly exposed to mercury by eating fish that contain mercury. It is released into the ecosystems via permafrost melts due to climate change. Mercury also enters ecosystems through burning of coal. It also enters water systems after it has been used in mines to extract metals like gold, and through the building of dams. When dams are built and land is flooded, microbes convert naturally occurring mercury in soils into toxic methylmercury. Fish are exposed to mercury through the water. Mercury levels get higher and higher in organisms that are further up the food chain. So, mercury levels are higher in larger fish, which eat lots of smaller fish, and they may become even higher in humans who rely on fish for food.

HYDROELECTRIC DEVELOPMENT: Hydroelectric engery, or hydroelectric power, is a form of energy that harnesses the power of water in motion - through a hydroelectric dam on a river, or a waterfall - to create electricity.

MIGRATION: Seasonal movement of animals, fish, humans, etc. from one region to another.

QUESTIONS TO CONSIDER

Below are some statements from Elders, land users, and community members about some of the concerns they have about the impacts of hydroelectric dams on the environment. Information about hydroelectric dam processes is also included. As you read the case study, consider the following questions:

1. What are some possible toxins associated with hydroelectric development?
2. How might toxins bioaccumulate within the watershed or ecosystem?
3. What are some potential environmental health issues associated with hydroelectric damming (consider abiotic and biotic factors)?
4. What aquatic management concerns exist regarding this development? What stakeholders are involved in aquatic management? What factors do these stakeholders consider and prioritize when making decisions about hydroelectric dams?
5. How do communities benefit from the development in long and short terms?

INDIGENOUS KNOWLEDGE ABOUT HYDROELECTRIC DAMMING

Hydroelectric dams have some major implications on traditional fishing practices and livelihood of Indigenous people, below are some quotes from Indigneous people about the impacts caused by the hydroelectric dams built in the river basin:

There's private property all along the banks from Hudson Hope to Fort St John so unless you own a boat, there's not many spots to fish from the banks. We are banned from the best fishing spots by Hydro anyway. They built a fence and put up signs and they have security. - Thomas Hale, Saulteau First Nation fisher, Treaty 8 Association of BC, p. 64, 2016-2017 Report

The fish in the area around Nonacho Lake are considered "ruined" due to the impacts of the Talston River Hydro Electric Project. The flooding that occurred as a result of that project led to changes in mercury levels in fish as well as other changes in the quality of fish tissue such that people no longer consider them good to eat. - Lutsel k'e portion of the 2016-2017 Tracking Change Report, p. 49

Whatever happens up here, Peace River, directly impacts us at home. There is a deep fear. One, BC Hydro did their own environmental assessment on Site C [Dam], how is that legal? Two, they are turning away nations saying there will be no impacts to rights and interests. When they first built the Bennett Dam, there were deep impacts, changes to water levels and quality. The Peace River is such an important river. Water is life, we can't eat money. We don't do anything at Beaver First Nation for money—we do things in a forward-thinking way. Money comes and goes, but the land is there forever. We have a hard time trying to understand land ownership. We don't own the land, we never owned the land. There is no such thing as land ownership, the land owns you. We have to shift our own thinking, we have to think about our children. I know our issues aren't going to be fixed by me or anyone else at this table – it's going to be our kids. - Treaty 8 Mackenzie All Chiefs Water Gathering Initiative, p. 40 2017-2018 Report

Water is number one. We came here to support anything and everything that T8TA (Treaty 8 Tribal Association) would like to do to support water. We have a real fear of water quality, water shortage. We have to do everything we can. You don't have to be a leader to speak your mind. We need everybody to stand up. If we teach our kids that that drop of water is the most important thing on the planet, they will grow up respecting it. – Chief Trevor Mercredi, Treaty 8 Mackenzie All Chiefs Water Gathering Initiative, p. 40 2017-2018 Report

Fish Parasites found in a fish from Łutselk´e
Photo Credit: Łutselk´e Dene First Nation provided by LauraJane Michel

Fish with a lesion on the lefthand side
Photo Credit: Łutselk´e Dene First Nation provided by LauraJane Michel

HYDROELECTRIC DAMMING PROCESSES

Hydroelectric dam construction (Adapted from: https://sciencing.com/what-are-hydroelectric-dams-made-out-of-13661668.html and https://www.miningandenergy.ca/energy/article/top_10_hydroelectric_dams_in_canada/)

Dams are constructed to stop the flow of water, and this creates a reservoir behind the dam. Energy is built up behind the dam and is then used to generate electricity by harnessing the flowing water. As water falls through the dam it turns a turbine which spins electric generators. Hydroelectric dams are constructed with great care- they need to be strong!

- **Earth**: Ground material is used to create a base for the dam, which sits in the river and blocks the flow of water. Operators try to use easily available material like rock and dirt to keep the cost down, while also creating a strong foundation to build the rest of the dam.
- **Concrete**: Next, concrete is poured around the layer of earth material to provide shape, structure, and strength to the dam. Workers use concrete in a near liquid form which is effective for making specific shapes. It is also useful because it hardens and holds its strength!
- **Steel:** This is the final part of hydroelectric dam construction. Whereas concrete is strong in terms of compression, it is not very strong with twisting or pulling. Steel rebar is put into the concrete to add additional strength. Without the steel, the water pushing against the dam could break the concrete.

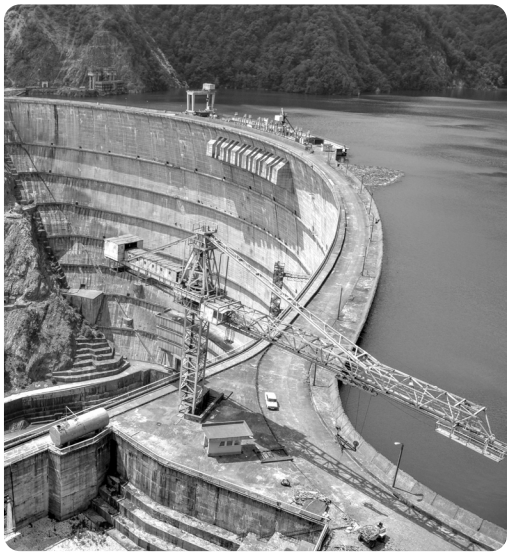
FACTS ABOUT HYDROELECTRIC DAMS IN CANADA:

The largest hydroelectric dam in Canada is the Robert-Bourassa hydroelectric generating station. It is location on La Grade River in Northern Quebec and is 162 meters high and 2,835 meters wide!

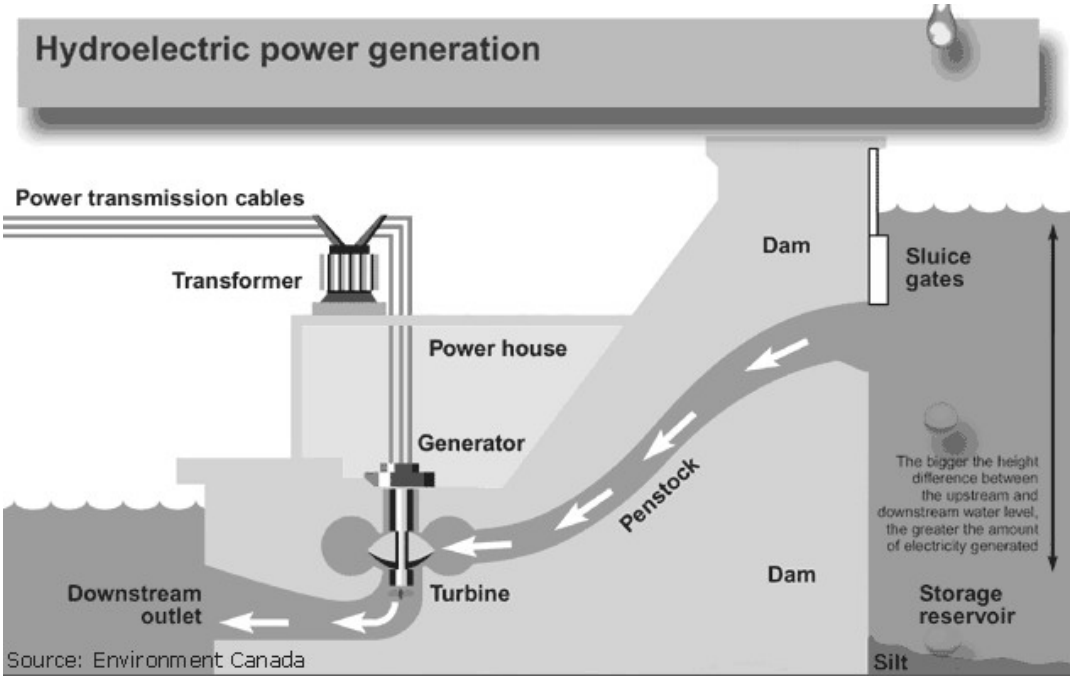
According to the Canadian Dam Association, there are over 15,000 dams in Canada, of which 1,157 are categorized as “large” dams (CDA, 2019).

Hydroelectric dam usage in Canada has resulted in Canada producing 60% of its power from its waterways (Kirby, 2015).

Over the next twenty years, it is estimated that Canada will spend $55 to $70 billion on new hydro projects (Kirby, 2015).



High water levels on one side of a hydro electric dam
Photo Credit: Alex Bagirov



Hydroelectric power generation process
Photo Credit: Environment Canada

HYDROELECTRIC DAM OPERATION

Adapted from: https://www.usgs.gov/special-topic/water-science-school/science/hydroelectric-power-how-it-works?qt-science_center_objects=0#qt-science_center_objects

Hydroelectric dams create electricity by using a source of energy, in this case water, to turn a propeller-like turbine. This turbine turns a metal shaft in an electricity generator, which creates electricity that you can use to power your refrigerator or charge your cell phone. Coal-fired power plants operate the same way, except they use steam to turn the turbine blades.

Dam operators tend to build hydroelectric plants on a large river with a drop in elevation. This is because the dam will be able to store a lot of water behind it and there will be a lot of energy built up to turn the turbine. Gravity causes the water to fall through the penstock and move the turbine at the end of the dam. A shaft connected to the turbine turns the electricity generator and creates power. Power lines carry the electricity from the generator to homes, buildings, and industrial site.

ENVIRONMENTAL IMPACTS

One of the main motivations behind hydroelectric power is that it is cleaner than many conventional energy sources- it is a great way to reduce Canada's greenhouse gas emissions! On average, hydropower emits 35 times less GHGs than natural gas and approximately 70 times less emissions than coal generation (Hydro Quebec, 2020). However, recent studies have also found that the decaying vegetation caused by hydroelectric dams also cause greenhouse gas emissions, further contributing to climate change. The environmental benefits of hydroelectric development is complicated. Unfortunately, there are still negative environmental impacts that result from hydroelectric development that must be considered. The dam blocks fish migrations which can separate fish spawning areas from rearing habitats. Sediment can also get trapped behind the dam, which is an issue because this material is needed to maintain the habitat downstream. One of the greatest environmental impacts of hydroelectric dams is the alteration in the water's natural flow. Aquatic ecosystems rely on the natural timing and quantities of water. Dams disrupt these natural rhythms and can result in flooding in irregular areas and low levels or non-existent water in other areas.

ECONOMIC CONSIDERATIONS

Hydroelectric dams make up 60.2% of Canada's electricity generation. Globally, Canada is the second largest producer of hydroelectric power and sells some of it's supply to the United States. The amount of hydroelectricity produced in each province differs significantly (Natural Resources Canada, 2019):

- Manitoba: 96.8%
- Quebec: 95.0%
- Newfoundland and Labrador: 93.7%
- Yukon: 92.2%
- British Columbia: 90.5%
- Northwest Territories: 38.5%
- Ontario: 25.9%
- New Brunswick: 19.6%
- Saskatchewan: 13.7%
- Nova Scotia: 8.8%
- Alberta: 2.5%

In the Northwest Territories, electricity rates that people pay to power their homes depend on how the electricity is generated in the community (Northwest Territories Power Corporation, 2014a). Communities that rely on diesel or natural gas are called "thermal communities" and they pay a higher rate for electricity than communities that are connected to hydroelectric plants. There are three hydro dams in the Northwest Territories: Snare Hydro System, Bluefish Hydro, and Taltson Hydro (Northwest Territories Power Corporation, 2014b).

Student Handout: Hydroelectric Damming Case Study Worksheet

NAME _____ **DATE** _____

Determine if the following statements are true or false:

_____ 1. The W.A.C. Bennett Dam is the largest dam in Canada.

_____ 2. Mercury is a naturally occuring toxic element that can cause serious health issues in fish and animals.

_____ 3. Steel is the final step when constructing a hydroelectric dam.

_____ 4. Hydroelectric dams produce over 80% of electricity in Canada.

_____ 5. Łutselk´e Dene First Nation has noticed and documented changes in fish health, such as parasites or toxins, due to hydroelectric development.

6. In your own words, describe the concept of "renewable energy." Would you consider hydroelectric development renewable?

7. What are some of the disadvantages of hydroelectric development?

Student Handout: Organization Table

NAME _____ **DATE** _____

Use this table to record information as you read through the case study, and refer back to it when you make your presentation.

You will likely have questions that come to mind as you learn about the development. Use this table to keep track of the questions you have and brainstorm different resources or people you would speak to to find out more information.

INFORMATION ORGANIZATION			
	What does the Case Study say? (Use bullet-points)	**What other questions do you have?**	**What kinds of information would you use to answer your questions? Who would you speak to find out more?**
What motivated the development?			
What stakeholders are involved in the development?			
What technical processes are used in the development? What contaminants result from the development?			
What does Indigenous Knowledge say about the development?			
How does the development impact people in positive and negative ways (social, economic, cultural, etc.)?			

Student Handout: How to Conduct an Interview

Generating Interview Questions:

It is important to prepare interview questions in advance in order to ensure that your key questions are addressed. At the same time, a good interviewer will also ask follow-up questions in order to acquire greater depth and subtlety from the interviewee. There are different types of interview questions:

1. Closed-ended questions require a simple answer (what is your name?), or a selection from a few set answers. Closed-ended questions are handy when you are interviewing a lot of people and want to easily compare their answers.
2. Open-ended questions require the person being interviewed to explain in some detail. Open-ended questions are helpful when you want to discover more depth or complexity. You might ask them as follow-up questions to things people have said earlier in an interview.

Activity: Interviews

Read and label each question below in the blank provided. For closed-ended questions, write "C," and for open-ended questions, write "O." (Adapted from NWT Heritage Fairs Teacher Manual https://www.pwnhc.ca/wp-content/uploads/2014/03/nwt_heritage_fairs_teacher_manual.pdf):

_____ 1. What was it like when you went fishing as a child compared to now?

_____ 2. When were you born?

_____ 3. You said earlier that knowledge from our ancestors informs how we should act on the land today. Can you tell me what you mean and provide an example?

_____ 4. Would you tell me about your memories of hunting caribou with your uncle?

_____ 5. Do you like dry meat?

Prepare a list of 5-7 interview questions that help you understand sustainability and fish harvest, including:

- values/traditions/practices that contribute to sustainability
- examples of sustainable fish harvest and/or ecotourism
- inhibitors to sustainable practices

Your questions should be specific to the interviewee and your specific community. Before the interview, be sure to write these questions clearly and with space to jot notes during the interview.

Best Practices for Interviews:

Willingness to be interviewed shows great generosity. By agreeing to an interview, a person expresses willingness to share personal experiences, perspectives, and stories. It is imperative that interviewers respect this generosity by maintaining professionalism and ethics in managing both the interview proper and the information that is shared. The experience should be positive for both you (the interviewer) and the interviewee!

Read through the following checklist and practice with a partner before conducting your formal interview. You will want to be familiar with the interview process, so that your formal interview goes smoothly. Even if you are using technology to record the interview, it is a good idea to practice notetaking during the interview in order to capture your own thoughts and responses.

Keep these best practices in mind when you're conduciting interviews for your project:

1. Locate a quiet place to set up and test the recorder.
2. If the person being interviewed is more comfortable in another language, then ensure you've planned for a translator.
3. Introduce yourself.
4. Begin by recording the person's name, the date of interview, and the location.
5. Explain the purpose of the interview and how you will use the information.
6. Have them sign a release form.
7. If you are using a tape recorder, pause early-on in the interview to check that your recorder is working.
8. Do more listening than talking.
9. Take necessary notes in your Journal. Ask for clarification of special language and terms.
10. Take pictures of the interviewee.
11. If you take pictures, have the interviewee sign a photo release form.
12. Write follow-up notes about your impressions, ideas, and questions you still need to ask.
13. If you recorded the interview, start transcribing as soon as possible. Sometimes you won't be able to hear answers from the tape, and it's better to transcribe while you can still remember the conversation.
14. Analyze your findings to identify the important points. Decide if any follow-up is needed.
15. Send your Interviewee a thank-you note.

Interview the Elder(s) or community member(s) using the students' interview guide. Students should take notes during the interview on a blank piece of paper. Following the interview, have students invite their interviewee(s) to the class Youth Knowledge Fair so that the knowledge holder can see the outcome of the interview.

Adapted from NWT Heritage Fairs Teacher Manual **https://www.pwnhc.ca/wp-content/uploads/2014/03/nwt_heritage_fairs_teacher_manual.pdf**

Assignment: Presentation & Guidelines

You are tasked with creating a presentation about the local disturbance/development issue you selected. Use information from the case study handouts, background research using the internet and print materials, and interviews with knowledgeable people to inform the presentation.

As you create your presentation, ensure you address the following:

1. What caused the issue? What was the motivation behind the development? What are the short-term and long-term proposed benefits of the development?
2. Describe the contaminants resulting from this development, focusing specifically on the bioaccumulation of contaminants in the aquatic environment, and resulting environmental health issues.
3. How has the issue been managed in the past and how is it being addressed today?
4. How might Indigenous knowledge be beneficial in studying this issue? How might it be useful in making a decision about/managing the issue?
5. Why is it important to consult local communities before engaging in industrial development? What are the challenges and possibilities you see in consulting local communities on the issue?

The following are some suggestions to help you create your presentation:

- The first step in a presentation is always to think about "what's the point"? Decide on 2-3 takeaways for the audience and then present content that will help you get your message across. Give your presentation a clear structure. Begin by stating the purpose of your talk and what you want the audience to take away. Then include content that helps address the topic you introduced at the beginning. Finish off with a conclusion and "takeaway" message.
- Find a way to engage with your audience. What questions can you ask your audience that will get them "hooked" at the beginning of your presentation? Think about times that you have been interested in a presentation and what the speaker did to keep your attention.
- Use software like Microsoft PowerPoint, GoogleSlides, or Prezi to guide your presentation. These tools allow you to display key points, facts, and images to help you respond to the prompt. If you do not have access to a computer, or would prefer to do a tech-free presentation, consider printing out images, writing/drawing on the board, playing a game, or distributing handouts.
- Effective presentations are not limited to a traditional presentation structure. Presenters can also use a variety of creative approaches to teach their audience about a subject. Consider creating a presentation/drawing, short film, skit, song, or poem as alternative ways of communicating your content.
- Consider learning words in the local traditional language for use in your presentation. Ask a language speaker for suggestions about words you should include. See the attached list of traditional words for some suggestions to start.
- Keep in mind these general presentation tips:
    - Be prepared with speaking notes, but do not read off a script.
    - Use hand gestures to emphasize your points.
    - Look your audience in the eye - it helps keep people engaged.

Student Handout: Presentation Rubric

NAME _____ **GRADE:____/20**

	4- Excellent	3- Good	2- Fair	1- Needs Improvement
Delivery	Holds attention of audience through eye contact; seldom uses notes; vocal variety in tone and volume; emphasizes key points	Consistent use of eye contact but returns to notes; speaks with satisfactory vocal variety in tone and volume	Displays minimal eye contact and mostly reads from notes; speaks with little vocal variety	No eye contact and entirely reads from script; speaks with no vocal variety which causes audience to disengage
Content/ Organization x2	Addresses selected issue with depth and creativity; provides clear purpose; includes important examples, facts, and evidence; demonstrates knowledge by answering all questions with strong explanations	Addresses selected issue well; somewhat clear purpose; some supportive examples, facts, and evidence; is at ease with answers to expected questions, without explanations	Somewhat addresses issue; attempts to define a purpose; provides weak examples, facts, and evidence; uncomfortable with information and answering questions	Does not address issue; does not define a purpose; weak or no supportive evidence of subject; does not have grasp of information and unable to answer questions
Enthusiasm/ Audience Awareness	Demonstrates strong enthusiasm during entire presentation; increases audience understanding; holds audience attention	Shows some enthusiasm for topic; raises audience understanding about most points	Shows little or mixed enthusiasm for topic; somewhat raises audience understanding on some points	Shows no interest in topic presented; fails to increase audience understanding
Visuals (slide show, handouts, movie, etc.)	Excellent and creative visuals engage the audience, enhance the presentation, and emphasize key takeaways	Visuals are appealing; visuals complement the presentation and emphasize key takeaways	Visuals are somewhat appealing/colorful; visuals are somewhat connected to the key takeaways	Little to no attempt to engage the audience with visuals
Comments				