# ALL ABOUT AGGREGATES: THE CONCRETE FACTS

## A Manitoba based Gr. 7 Curriculum Supplement for Cluster 4: The Earth's Crust

LAFARGE
Building better cities

MANITOBA MODEL FOREST

**TO THE TEACHER**

*This teacher's resource package is intended for use in the Grade 7 Curriculum: CLUSTER 4: THE EARTH'S CRUST. It is our hope that this curriculum package will enhance student learning in the earth sciences. CLUSTER 4 learning outcomes are shown below.*

# Grade 7, Cluster 4: Earth's Crust

## OVERVIEW

In this cluster, students investigate the Earth's geology, including rock and mineral formation, changes in the landscape over time, and human use of geological resources. Students describe processes involved in the location, extraction, processing, and recycling of geological resources found in Manitoba and Canada. Students recognize that soil is an important natural resource and they discuss the importance of soil conservation. Students identify environmental, social, and economic factors that should be considered in making informed decisions about land use. They examine theories explaining the Earth's geology, and recognize the role of technology in the development of new scientific theories. Specialized careers involving the science and technology of the Earth's crust are also explored.

## GENERAL LEARNING OUTCOMES:

**7-0-9b:**

Students will express interest in a broad scope of science and technology related fields and issues

**7-0-9e:**

Students will be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment

## SPECIFIC LEARNING OUTCOMES:

**7-4-03**

Students will describe the geological processes involved in rock and mineral formation, and classify rocks and minerals by their method of formation

**7-4-04**

Students will investigate and describe the process of weathering and erosion, and recognize that they cause changes in the landscape over time. Include: physical, biological, and chemical weathering.

**7-04-05**

Students will explain how rocks on the Earth constantly undergo a slow process of change through the rock cycle.

**7-04-07**

Students will identify geological resources that are present in Manitoba and Canada, and describe the processes involved in their location, extraction, processing, and recycling. Include: fossil fuels, minerals

**7-04-08**

Students will identify environmental impacts of geological resource extraction, and describe techniques used to address these

**7-04-09**

Students will recognize that soil is a natural resource, and explain how the characteristics of soil determine its use

**7-04-1**

Students will identify environmental, social, and economic factors that should be considered in making informed decisions about land use.

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## PART 1: THE STORY OF ROCKS: WHERE DID THEY COME FROM?

**In this part you will:**

Learn what rocks are
Find out how all rock was formed
Identify 3 basic rock families and the rock cycle

### 1A. WHAT ARE ROCKS?

Rocks are non-living solid materials made from a variety of minerals. They were formed as the earth's crust cooled from a molten state.

### 1B. HOW DID ROCKS FORM, AND WHAT ARE ROCK FAMILIES?

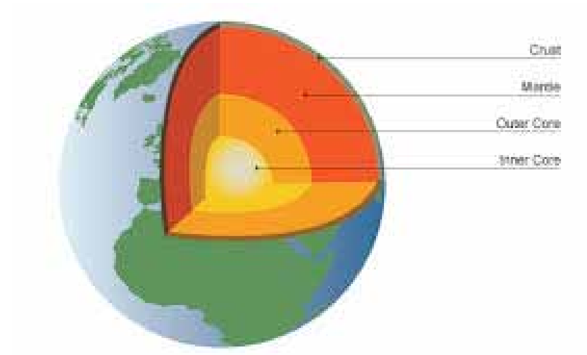



Figure 1: Earth's Crust

About 2/3 of the Earth is covered by water, but even the ocean floor is made of rock. Early in the Earth's history, molten material cooled and produced IGNEOUS ROCK. Since then, a variety of natural forces have acted on them. These forces include ice, water, wind, and gravity. When rocks are broken down, the smaller particles are washed or carried away, and collect in layers called SEDIMENTS. These sediments build up in layers and become cemented together, where they are known as SEDIMENTARY ROCKS. These sediments usually contain bits of plant and animal remains, known as FOSSILS. As the layers build up, they become so heavy that water is squeezed out and replaced by minerals that were dissolved in the water. About 75% of the rock we see on the landscape is SEDIMENTARY. Over longer periods of time, sedimentary rocks can break down into smaller and smaller particles, and build up over centuries of time with decaying plant life to form SOIL.

Rocks can even change form. Rocks are exposed to intense heat and pressure just below the Earth's crust, in a zone known as the MANTLE. When rock is subjected to even greater pressure from above, it can be forced deeper down towards the mantle layer. This causes it to transform into another type of rock known as METAMORPHIC ROCK. ( from Greek words meta = LARGE, and morph = CHANGE SHAPE).
Rock can change from one type to another in a complex process known as the ROCK CYCLE.

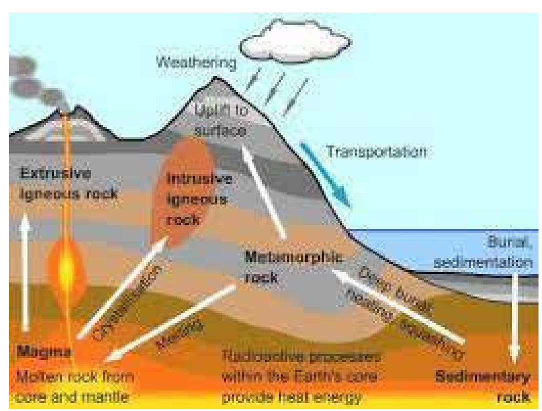



Figure 2: Rock Cycle

### 1C. WHAT IS THE ROCK CYCLE?

The ROCK CYCLE begins when magma from the Earth's mantle layer is squeezed to the surface. It cools down and forms IGNEOUS ROCK. This rock is exposed to the forces of weathering and erosion, and forms small particles of rock that are washed away or roll downhill. The smaller particles collect in layers called sediments, and form SEDIMENTARY ROCK. Over time, the sediments become so thick and heavy that they are compressed downward into the mantle, where they become so hot and experience such pressure that they change their structure. At this point they are called METAMORPHIC ROCKS. They eventually melt, and become MOLTEN. If this molten material escapes from the mantle layer to the earth's surface, it is known as LAVA. This lava will cool down and form EXTRUSIVE IGNEOUS ROCK; then the entire cycle starts over again. If, however, the lava does not reach the surface, it will be trapped inside the Earth's crust and then cool down. This is known as INTRUSIVE INGNEOUS ROCK.

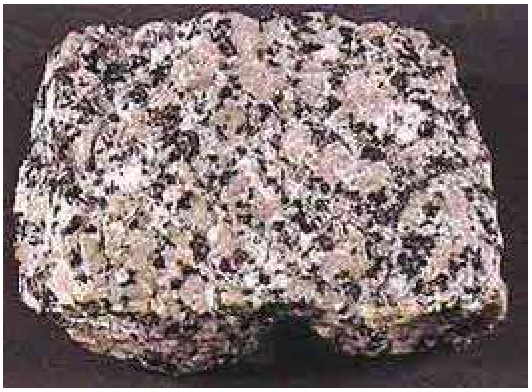


Figure 3: An igneous rock. These rocks can be identified by the crystallized minerals that formed as the magma cooled.

## PART 1 ASSIGNMENT:

Name the three main rock families.
Explain how each rock family forms.
Describe the rock cycle beginning with an extrusion of igneous rock onto the Earth's surface.

OPTIONAL PROJECT A: Collect 3 rock samples from each of the rock families. Attach them to a backing of either wood or cardboard. Using arrows and text, illustrate how rocks can change from one family into another.

OPTIONAL PROJECT B: Using magazines such as National Geographic, create a poster that shows the impact of the rock cycle on humans. For example, you may want to show volcanic activity and its effect on infrastructure such as roads and cities. You may also want to show weathering, and how such things as landslides, mudslides, and other catastrophic events have had an effect on human activities such as transportation and agriculture.

OPTIONAL PROJECT C: Large deposits of sedimentary rock are often associated with fossil fuels. Create a brief report on "Hydraulic Fracturing" of sedimentary rock, or "fracking" to extract "shale gas" (natural gas found in small spaces with sedimentary deposits). Be sure to mention the possible environmental impacts of this new technology on ground water resources.

## PART 2: FORCES AS WORK: BREAKING DOWN ROCK INTO SAND AND GRAVEL

**In this part, you will:**

Learn about the forces that break down rock
Identify specific Manitoba landforms created by forces acting on rock
Explain how specific landforms containing aggregates were created
Learn how to identify sand and gravel according to their particle size

### 2.1 HOW FORCES BREAK DOWN ROCK

Most sand and gravel deposits were formed either directly or indirectly by glaciers during the last Ice Age, from 2 million years to 10,000 years before the present. The ice sheet over Manitoba was over 1 km thick. As this huge mass of ice scraped over the rocky landscape, it broke off chunks of bedrock and scoured the earth's surface, leaving marks in surface rock called STRIATIONS.
As the continental ice sheet retreated, due to a warming climate, glacial meltwater flowed along the margins of the glacier, sometimes creating huge crevasses. These meltwater streams flowed within, on, and below melting glaciers. They carried gravel and sand in the current, and when the streams dried up, the stream bed was left intact. This geological feature is known as an ESKER. In northern Manitoba, eskers were used by First Nations as travel routes, as they were sometimes several meters higher than the surrounding swampy land. Large boulders left behind as the glacier receded created a rock strewn landscape known as an OUTWASH PLAIN.

Figure 4: an ESKER. In the north, they are the preferred route on which roads are built, since they are high and dry, and are essentially already made of gravel.

## 2.2 HOW SPECIFIC LANDFORMS WERE CREATED BY FORCES ACTING ON ROCK


Figure 5: Glacial Lake Agassiz was a huge inland lake created by melting of the last continental ice sheet. Many of our landscape features visible in Manitoba were created by this lake.

The flow of glacial melt water from the last ice age also created a number of other deposits. BEACH RIDGES, DELTAS, AND SAND BARS were left on the landscape when the ice sheet retreated northward. Perhaps the best known example in Manitoba is glacial LAKE AGGASIZ (Fig. 5), which covered much of southern Manitoba, Saskatchewan, and North Dakota. The beach ridges can clearly be seen on the landscape today. You can see the beach ridges from a distance as you drive along Highway 44 to Milner Ridge, or the Bedford Ridge as you drive along Highway 201 toward the community of Vassar. These ancient beach ridges are mined today for their valuable deposits of sand and gravel. Very fine sand known as SILICA SAND was mined on Black Island on Lake Winnipeg. This sand is known as ALLUVIAL SAND, which was created when very fine sand particles were carried by river currents and settled out of suspension when water flowed into a relatively calm body of water such as an inland lake. Silica sand is heated until it reaches a molten state, and is used in the production of glass. Similar deposits of very fine sand can be found along the shore of GRAND BEACH PROVINCIAL PARK, rated as one of the world's top ten beaches because of the quality of the sand.

Other nearby evidence of glacial deposits can be found in the community of GULL LAKE, where huge boulders were left behind in an OUTWASH PLAIN. A large sand delta created the sand hills in the SPRUCE WOODS PROVINCIAL PARK and the LAUDER SANDHILLS, when the ASSINIBOINE RIVER flowed into LAKE MANITOBA. Known as the "MANITOBA DESERT", it is not a true desert because it receives just as much precipitation as other areas in southern Manitoba.

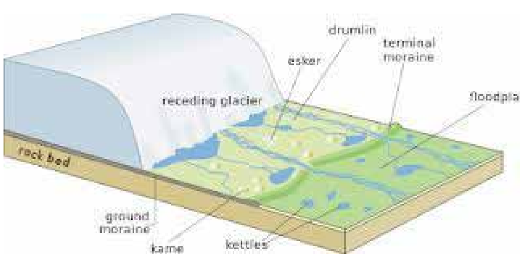



Figure 6: Diagram showing features of our landscape created by a receding ice sheet.

## 2.3 HOW SPECIFIC AGGREGATE-CONTAINING LANDFORMS WERE FORMED IN MANITOBA

Other features of the post-glacial landscape are DRUMLINS, KAMES, AND KETTLES. They can be seen in the diagrams below:

DRUMLINS are streamlined deposits of sand and/or gravel shaped like a teardrop. The tapered end points in the direction of the glacier's movement.

When glacial meltwater flowed up against a solid wall of stagnant ice, the deposits of sand and gravel were dumped into a pile, and remained there when the ice receded. This created a structure known as a KAME, and is also composed entirely of sand, gravel, and boulders.

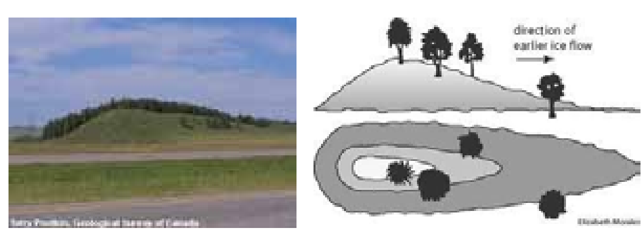



Figure 7: Diagram showing the appearance of a drumlin and how it was created by glacial deposits.

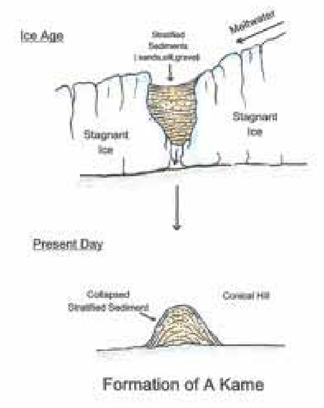



Figure 8: This diagram shows how a kame was created as the ice sheet melted.

Figure 9: a KAME is a small hill composed of sand and gravel deposits

Figure 10: Kettle lakes typical on our northern prairie landscape. These ecosystems are very important to populations of waterfowl.

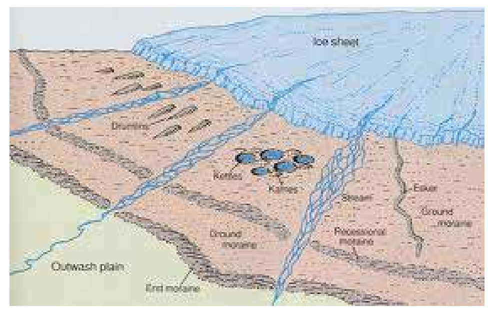



Figure 11: This diagram shows how kettles were formed as the ice sheet receded.

## 2.4 THE SIZES OF SAND AND GRAVEL PARTICLES

The combined forces of glaciation and flowing water left behind valuable deposits of sand and gravel on the landscape. Let’s find out what they are used for, and how they are processed.
So exactly what is sand and gravel? They are unconsolidated (loose) AGGREGATES, or natural accumulations of rounded rock and mineral fragments. Sand and gravel is defined by their particle sizes.
SAND consists of rock or mineral particles from .05 mm – 2.0 mm in size. GRAVEL consists of particles anywhere from 2 mm up to 100 mm. Geologists further separate gravel and larger rock particles according to the following sizes:

GRANULES OF ROCK: 2 mm to 4 mm ( 1/32 of an inch to 1/8 inch)
PEBBLES: 4 mm to 63 mm (1/8 of an inch to 2.5 inches)
COBBLESTONE: 63 mm to 254 mm ( 2.5 inches – 10 inches)
BOULDERS: > 254 mm ( 10 inches)

## PART 2 ASSIGNMENT:

Define the following terms:

- striations
- esker
- silica sand
- alluvial sand
- drumlins
- kames
- kettles
- aggregates:

Describe the size ranges of sand as compared to gravel.

OPTIONAL PROJECT A: The last Ice Sheet retreated approximately 10,000 years ago. It covered most of Canada, and some parts of the United States. On a map of North America, show how far the last 4 ice sheets pushed into the United States. Explain why they couldn't go even further south.

OPTIONAL PROJECT B: From the list of definitions above, select one. Using a digital camera or smart-phone, take a picture of one of these remnants of the ice age, and explain to your class how it was formed.

## PART 3: HOW HUMANS USE AGGREGATES

**In this part you will**

- Learn about the history of the use of sand and gravel
- Explain how sand, gravel, and crushed limestone are mined
- Make a small batch of cement and pour concrete into a mold
- Learn about the process of reclaiming old gravel pit mining sites

Figure 12: A corduroy road under construction through a very swampy black spruce lowland

### 3.1 THE HISTORY OF SAND AND GRAVEL USE IN MANITOBA

There was little or no demand for sand and gravel in Manitoba prior to 1900. Wood was used in the construction of sidewalks, or boardwalks until about 1900. Around that time, wood plank sidewalks were replaced with concrete sidewalks, and building foundations were being replaced with concrete rather than cut stone blocks. Dirt roads began to be surfaced with gravel as the automobile became more and more popular.

In Manitoba's past history, roads became so muddy during spring thaw or summer rainstorms, that they became nearly impassable. Rural people would often cut logs and place them directly on the road bed to create a surface to drive on. These were known as "CORDUROY ROADS ". They were extremely rough and bumpy, and designed for low speed only. If a vehicle slipped off the corduroy road, it often took a team of horses and a very muddy afternoon to pull it out of the muck. In those days, before a modern "Department of Highways and Infrastructure", it took a group of neighbours from the local community to build a corduroy road through a swampy area. Many "cords" of wood were used in the construction of the road, hence the name CORDUROY".

Figure 13: Before the use of aggregates such as gravel, rural roads were unpredictable during wet weather. Today's all-weather road system has provided safer, more reliable transportation.

### 3.2 HOW AGGREGATES ARE MINED

Even before the mining operation begins, steps must be taken to ensure that the land can one day be reclaimed. This means that a proper procedure must be in place before the machinery starts working. Typically this means that:

- All vegetation must be removed from the site
- Topsoil must be removed and stockpiled for later use
- Waterways must be protected if the water table will be intersected by the mining activity
- When mining is complete, the land must be contoured
- Topsoil is replaced
- All building and other infrastructure used at the mine site must be removed and all debris must be cleaned up
- The area must be re-vegetated

There are many complicated issues that need to be addressed even before mining begins. These questions deal with concerns related to environmental protection, mining economics, and public safety. Some of these questions include:

What is the gravel being used for?

- How will the gravel be mined?
- What are the proposed seasons of operation?
- What are the proposed hours of operation?
- How will gravel be transported from the site?
- What is the proposed route of transport and ultimate destination of the gravel?
- What screening techniques will be used?
- How will topsoil be reserved?
- What methods will be used to store or dispose of brush, stripping material, and overburden?
- What methods will be used to dispose of oversize (i.e. boulders) and undersize (i.e., fine sand) material?
- What erosion control measures will be used?
- How will dust be controlled?
- Where will gravel reserves be stockpiled at the site?
- Will mining intersect the groundwater table?
- Will the mining area be dewatered?
- Will water be discharged from the site?
- Will groundwater flow be altered?
- Will any protected waters or wetlands be altered?
- What processing methods will be used?
- Where will processing facilities be located?
- What are the proposed hours for the processing facilities?
- Will washing operations require water appropriations?
- How will chemical substances be stored on the site?
- How will access be controlled?
- Where will fences, gates and signs be located?
- How many people will be employed at the site?
- What type of office facilities will be provided?
- What equipment will be stored on site and where will it be located?
- What environmental permits are required for operation?
- What reclamation plans are in place?

The method of aggregate mining depends on the depth of the water table. Kame, esker, and outwash deposits are generally above the water table and can be mined by large equipment such as bulldozers and excavators as seen below (Fig. 14 and 15)

Gravel and sand deposits found below the water table are mined using DRAGLINES - diesel

Figure 16. Gravel stockpile are stored according to particle size

powered shovels with long reaches. Mining below the water table creates an artificial lake.

After removal from the ground, aggregates are transported by front-end loaders or trucks to a processing plant and placed through a series of SIEVES, or screens, to create the desired sizes. In some cases, larger gravel sizes are crushed into smaller sizes. Then they are stored in cone-shaped stockpiles.

Material is then hauled to job sites by large dump trucks. These trucks are weighed before they leave the gravel pit so that the customer knows the amount they need to pay. Gravel is sold by the metric tonne (2,200 pounds). A metric tonne of gravel is about .6 cubic metres. Because transportation costs for hauling gravel are so high, it is important for aggregates to be processed close to urban centres where most aggregates are consumed. Winnipeg is fortunate to have large gravel deposits nearby, specifically in the Birds Hill area. Birds Hill is actually a glacial moraine ridge, deposited when the last ice sheet receded 10,000 years ago.

Figure 17: The limestone deposits in this Lafarge quarry located in the Stonewall area will provide crushed rock for many years

**3.3 HOW SAND, GRAVEL, AND OTHER AGGREGATES ARE USED**

Aggregates such as sand, gravel, and crushed rock are the most commonly used mineral commodity in Canada. The dominant use of sand and gravel (known as CONSTRUCTION AGGREGATES) is in the production of concrete and asphalt. Most building, bridges, sidewalks and urban highways are made of PORTLAND-CEMENT CONCRETE. ASPHALTIC OR BITUMINOUS CONCRETE, which is sometimes called “blacktop”, or PAVEMENT, and is used mainly for rural highways, parking lots, and driveways. It takes about 80,000 tonnes of gravel aggregate to make a one kilometre length of paved highway. Gravel aggregates are used alone or with a binding agent such as tar on rural secondary roads.

Other aggregates used include “crushed rock”. Limestone, a sedimentary rock, is the most common material used to make “crushed rock”. Large pieces of limestone bedrock are blasted using explosives. Then the large chunks of rock are hauled to a crusher, a large machine which grinds the larger pieces into smaller ones. The crushed pieces of rock are then sent through a variety of screens, which have a variety of sizes of openings. The most common sizes are 6 inch (15 cm), 2 inch (5 cm) and ¾ inch (2 cm). Particles of crushed rock smaller that 2 cm are known as “3/4 down”.

About ¾ of all crushed rock is used as a base or sub-base in road construction. Other uses for crushed rock include drain stone, riverbank stabilization, landscaping, and as an ingredient in concrete. Some small stones (around 5/8 inch and smaller) are added to tar to create asphalt.

Figure. 18. Large pieces of limestone are hauled by truck to a crusher, where they are crushed into smaller pieces. Most of the crushed rock is used as a base layer for road construction.

Other uses of aggregates include drainage media, filtration beds for septic systems, sand-blasting operations, and improving traction on icy roads, especially at intersections.

DID YOU KNOW?

The same forces that erode rock into smaller particles are at work on our highways and roadways. Freeze/thaw cycles create cracks in the concrete when water enters openings and then freezes ( ice expands when water freezes). Repeated pounding by vehicle tires can enlarge the crack and create a POTHOLE. Frost under the asphalt or concrete can create a heaving effect from underneath and when it thaws, the roadbed can subside, and create cracks. Salt used in the winter can further weaken concrete. For this reason, each spring in Manitoba, ROAD RESTRICTIONS are placed on roads, whereby limits are placed on the weight carried by large commercial trucks. Without restrictions in place, severe road damage would occur because of the high downward pressure placed on the roadbed by these large transport trucks.

Figure 19: Potholes such as this can damage vehicles, and each year millions of dollars are spent repairing them.

Figure 19A: Sometimes a pothole can continue to grow until it forms a sinkhole. Sinkholes can create serious public safety issues.

# LAB ACTIVITY: LET'S MAKE CONCRETE!

What is the difference between "cement" and "concrete"? Concrete can be described as a "man-made or synthetic sedimentary rock". Concrete is a mixture of Portland cement, aggregates such as gravel and sand, water, and a reinforcing material such as steel bars, commonly known as "rebar". Portland cement is the substance that binds the aggregates together. It is produced by heating limestone, clay, and other materials to a high temperature. Because concrete is a semi-fluid, it can be poured into a variety of forms before it hardens.

## The Basic Mix:

**A general teacher's guide for concrete preparation:**

The physical properties of density and strength of concrete are determined, in part, by the proportions of the three key ingredients, water, portland cement, and aggregate. You have your choice of proportioning ingredients by volume or by weight. Proportioning by volume is less accurate, however due to the time constraints of a class time period this may be the preferred method.

An "old rule of thumb" for mixing concrete is 1 cement : 2 sand : 3 gravel by volume. Mix the dry ingredients and slowly add water until the concrete is workable. This mixture may need to be modified depending on the aggregate used to provide a concrete of the right workability. The mix should not be too stiff or too sloppy. It is difficult to form good test specimens if it is too stiff. If it is too sloppy, water may separate (bleed) from the mixture.

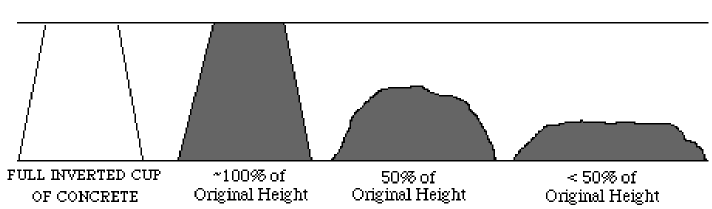
Remember that water is the key ingredient. Too much water results in weak concrete. Too little water results in a concrete that is unworkable.

**Suggestions:**

If predetermined quantities are used, the method used to make concrete is to dry blend solids and then slowly add water. It is usual to dissolve admixtures in the mix water before adding it to the concrete. Superplasticizer is an exception.

Forms can be made from many materials. Cylindrical forms can be plastic or paper tubes, pipe insulation, cups, etc. The concrete needs to be easily removed from the forms. Pipe insulation from a hardware store was used for lab trials. This foam-like material was easy to work with and is reusable with the addition of tape. The bottom of the forms can be taped, corked, set on glass plates, etc. Small plastic weighing trays or Dairy Queen banana split dishes can be used as forms for boats or canoes. Using a paper towel lightly dipped in vegetable oil,be sure to coat your form with a film of oil so that the concrete will release from the mold.

To answer the proverbial question, "Is this right?" a Slump Test may be performed. A slump test involve filling an inverted, bottomless cone with the concrete mixture. A Styrofoam or paper cup with the bottom removed makes a good bottomless cone. Make sure to pack the concrete several times while filling the cone.



Carefully remove the cone by lifting it straight upward. Place the cone beside the pile of concrete. The pile should be about 1/2 to 3/4 the height of the cone for a concrete mixture with good workability.
(SEE DIAGRAM)

**NOTE:**

This is a good approximation if no admixture chemicals are being used.
To strengthen samples and to promote hydration, soak concrete in water (after it is set).
Wet sand may carry considerable water, so the amount of mix water should be reduced to compensate.
Air bubbles in the molds will become weak points during strength tests. They can be eliminated by:

i. packing the concrete.
ii. Tapping the sides of the mold while filling the mold.
iii. "rodding" the concrete inside the mold with a stirring rod

To multiply or change the experiment, special chemicals called "water reducing agents" are used to improve workability at low water to cement ratios and thus produce higher strengths. Most ready-mix companies use these chemicals, which are known commercially as superplasticizers. They will probably be willing to give you some at no charge.

You can buy a bag of cement from your local hardware store. A bag contains 94 lb. (40kg) of cement. Once the bag has been opened, place it inside a garbage bag (or two) that is well sealed from air. This will keep the cement fresh during the semester. An open bag will pick up moisture and the resulting concrete may be weaker. Once cement develops lumps, it must be discarded.

## PART 3 ASSIGNMENT:

Many of our rural roads in Canada are not paved. Explain how a gravel road is designed and built.
Explain the steps involved in mining aggregates.

What is a cubic meter?

List the various uses of crushed rock.

How is asphalt made?

OPTIONAL PROJECT A: Imagine that aggregates have not yet been discovered. What would your home, your school, or your community look like without concrete, asphalt, and other aggregate products? Describe it in writing , or use sketches to illustrate what it might look like today.

OPTIONAL PROJECT B: Using a digital camera or smartphone, create a picture gallery of recent infrastructure projects using aggregates or aggregate products. Try and capture images of at least 10 of them.

OPTIONAL PROJECT C: Your class will play the role of a large city or town council. A developer has purchased a large block of land and is planning to mine the aggregates and build a cement plant, and will be stockpiling gravel to sell to road construction companies. Create a list of 10 issues that you would like to see addressed before permission is given to proceed with the development.

# PART 4: GIVING BACK TO THE LAND: RECLAMATION OF AGGREGATE MINING SITES

After mining, sand and gravel pits need to be reclaimed. Un-reclaimed pits can create a number of problems. Their vertical cliffs can be dangerous to people using the area. Some pits have very deep, cold water that can cause hypothermia. Erosion is a concern if sediments enter water sources downstream, especially if the aggregates are washed during processing. Un-reclaimed pits often create problems associated with illegal dumping of waste.

If they are near a populated centre, gravel pits can be reclaimed and converted to housing developments. They can be landscaped and turned into golf courses or other recreational uses. Wetlands and lakes can be created during the reclamation process, providing opportunities for boating, swimming, or even fishing.

One example of this is the FORT WHYTE ALIVE in Winnipeg. Formerly used as a clay mining site used in the manufacture of cement, the area has a number of artificially created lakes. These lakes are stocked with fish, providing visitors with angling opportunities. These lakes are large enough for canoes and small sailboats, creating recreational opportunities. Migrating waterfowl use the lakes as a staging area during their annual migration south. The aspen forest has returned, and with its adjacent prairie grassland, it is home to a thriving herd of bison. Whitetail deer, prairie dogs, rabbits, and song birds are abundant. This area is an "island of habitat" on the western edge of Manitoba's capital city. For some urban residents, this is their first encounter with nature.

Another example of pit reclamation can be seen in the Stonewall area. The pit is actually undergoing reclamation as the aggregates are being mined. Eventually the land will revert back to a natural state, suitable for parks, housing, agriculture, or a variety of other uses. There is a cost involved in reclaiming the gravel pits. Companies that extract aggregates, such as sand and gravel, are assessed a fee (per tonne) by the province. The funds collected are then used by the company to carry out reclamation work.

Figure 20: Aerial view of FortWhyte Alive. This reclaimed clay pit, formerly operate by Canada Cement – Lafarge, has now returned to a natural state.

Figure 21: One of the key roles of the Fort Whyte Nature Centre is public education. Here a group of students examining various species of wildflowers.

Figure 22: FortWhyte Alive is home to a growing herd of Bison.  The centre also boasts an urban market garden, rental cabins, guided tours, and offers a variety of workshops on sustainable living.

Figure 23: The Lafarge quarry in the Stonewall area is being actively mined, and rehabilitated at the same time. The walls of the quarry are gently sloped and seeded with grasses and alfalfa to prevent erosion. The image shows only 1 year of re-growth.

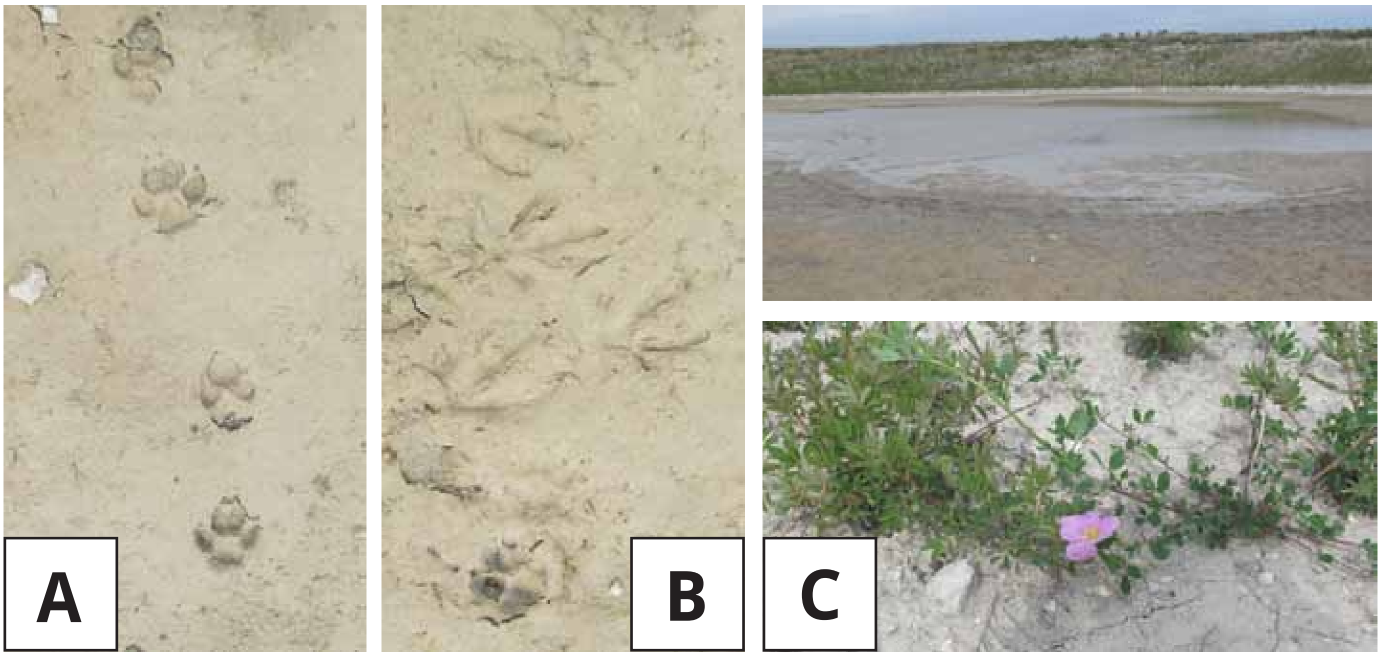



Figure 24: Plant and animal life is returning to the reclaimed quarry.

A. Coyote tracks
B. Waterfowl tracks
C. Wild rose bush growing beside an alfalfa plant

Gravel pits in the Stead/Belair area will yield many years of construction materials. While not currently being used, they are said to be “idle”. Natural succession has resulted in plant growth in the area, and habitat for animals. Surveillance cameras placed in local gravel pits captured these images:

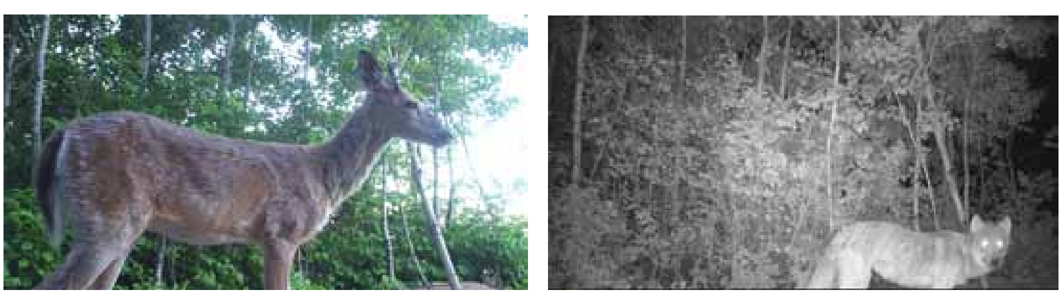


Figure 25: Local wildlife was detected on trail cameras in the Belair area. At left is a Whitetailed Deer, and shown at right is a Timber Wolf. The Wolf, like most predators, prefers to hunt at night. The presence of predator and prey species means that the ecosystem if functioning normally.

Figure 25: Vegetation is returning to this  Lafarge gravel pit in the Belair Forest area. Note the trees and shrubs in foreground. They make good habitat for songbirds and small mammals such as rabbits and mice, and the fox,coyote, and other predators that feed on them.

## PART 4 ASSIGNMENT:

Make a list of the hazards of an un-reclaimed gravel pit.

What uses can be made of reclaimed gravel pits.

What is natural succession?

OPTIONAL PROJECT A: Try and visit a reclaimed aggregate mining site such as a gravel pit or limestone quarry. Look around at the site and explain how the area is returning to its natural state. Take photos of vegetation and animal sign and create a photo gallery of the site.

# PART 5: CAREERS IN THE AGGREGATE MINING INDUSTRY

There are many careers available in the aggregate industry. Below is a summary of the types of jobs available. There are many opportunities for employment in the growing field of aggregates and aggregate production.

Below is as summary of the professional fields represented in the aggregate industry:

Mining, Civil, Mechanical, and Industrial Engineering: Manage the mine, quarry, or pit on a day to day basis. They are ultimately responsible for all aspects of operation.

Geology: Responsible for locating, mapping, and inventory of mine or quarry resources

Environmental: Responsible for ensuring that all mining operations are carried out in compliance with all laws and regulations governing the land, such as air, water, and soil

Safety and Health: Responsible for ensuring the health and safety of all employees involved in the mining or quarry operation

Accounting and Finance: responsible for day to day financial aspects of mine operation, from keeping track of sales of product, to meeting payroll for employees, and financing new equipment and other large purchases. They also keep track of all financial documents, and submit appropriate taxes and fees to government

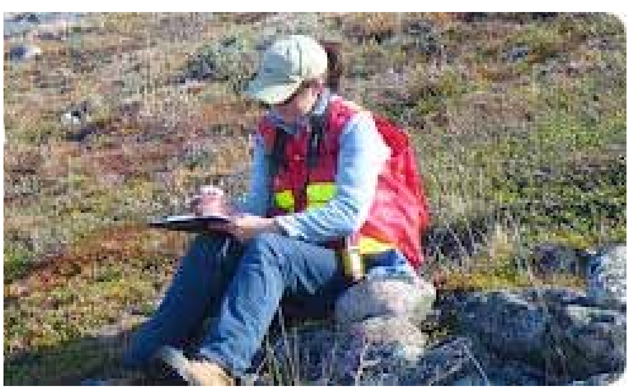
Information Technology: responsible for the computer network which handles all relevant data in the company

Manufacturing Operations: responsible for supervising the production of materials from the quarry, such as crushed rock, or other products that may be made on site such as cement

Sales and Marketing: responsible for the advertising and sales of the products from the mine or quarry

Human Resources: recruit, hire, and train staff for a variety of occupations in the industry

Other jobs in the aggregate industry involve the transportation of the various products. These involve heavy equipment operators, truck drivers, crusher operation, mechanics, dispatchers, and fleet managers. Skills learned in these trades are fully transferable to other industries such as forestry and agriculture.



A geologist surveys a site to assess its potential for aggregate production

An engineer inspects a newly designed crusher before being put into service

The career paths of four different Lafarge employees are summarized below.

## Career Profile:

**Name:** Nicholas Legal

**Occupation:** Quality Control Engineer

**Employed by:** Lafarge Canada Inc.

**Education and Training:** A five year Bachelor of Science in Civil Engineering degree, along with American Concrete Institutes Technician Grade 1 Concrete Tester.

**Your Job description**: I make sure the product that we deliver meets all job requirements along with ensuring that it meets our high standards. To do this I will review specs, review our in house and external strength results, review consistency of the material that goes into concrete, deal with any issues that a client may have, and manage the lab personnel to make sure we have coverage of all plants and high specification jobs.

**Rewards of Your Job:** Knowing that you had a part in any particular project such as roadways, bridges, buildings, etc. is a great feeling of accomplishment and pride for me. At any point I can drive through the City of Winnipeg and surrounding areas and can find a project that I was involved in. It's just a great feeling.

**Advice for getting into the field:** Getting an Engineering degree or a diploma in Civil Engineering Technology.

**Name:** Dawn Fraser

**Occupation:** Environment Manager

**Employed by:** Lafarge Canada Inc

**Education and Training:** I have a Bachelors of Arts degree in Environmental Studies from the University of Winnipeg. I also have background and training as an ESL teacher, an environmental researcher and as an environmental educator with youth groups.

**Your Job description:** I oversee the environmental management at all our facilities in Manitoba, Saskatchewan and several US states. I ensure our sites and employees are complying with the laws and regulations in their areas and are meeting Lafarge standards in environmental protection. This is done through training of employees and conducting audits of the facilities. Should an environmental incident occur on one of these sites, I manage the response and the clean-up. I also aid in creating reclamation plans and community partner programs for our quarries and aggregate sites to increase biodiversity and best reuse of the land. Working towards greater sustainability at all of our sites in biodiversity, energy management, water use, carbon emissions, and supporting local communities are some of the goals of the projects I work on.

**Rewards of Your Job:** The best thing about the environmental field is how holistic and multi-disciplinary it is, which means I'm constantly learning new things – from concrete to entomology to water chemistry. It is definitely never boring! Working with diverse groups and being able to get out into the community to work on projects and share knowledge is what I love the most.

Advice for getting into the field Getting a science degree in geography, environment or biology is the best way to get into the environment field. However, that said I came into the field with a BA which is possible with additional background experience or training, such as volunteering.

**General Comments:** Best advice to young students – find something you enjoy and volunteer in that area. You will get great work experience, knowledge, meet some excellent peers and mentors and learn if you will enjoy the job. Networking is a key factor to success, get involved in local industry associations – they often have a student chapter.

**Name:** William Gowdy

**Occupation:** Regional Geologist

**Employed By:** Lafarge Canada Inc. Western Canada (Manitoba to British Columbia)

**Education and Training:** Geological Technologist Diploma, Sir Sandford Fleming College

Bachelor of Science (Geology), Queen's University.

25 years exploration experience in Canada, USA, Guyana, Panama, Mexico, Indonesia

**Your Job Description:** Locate and access the potential sand and gravel deposits and quarry materials for construction purposes. My work involves looking at the chemical and physical properties of construction materials using a variety of lab tests, geophysics, geochemistry, remote sensing, air photo interpretation, geologic mapping, and various drilling techniques. Information generated from field and lab work is in turn used in Geographic Information Systems (GIS), and mine design software packages to aid in business and resource management decisions.

**Rewards of Your Job:** Work has exposed me to see numerous deposit types, geographic areas and cultures around the world. It has been a unique mixture of both field and office work. The work is challenging in that the science and technology are constantly evolving and one has to continuously learn and adapt with it.

**Advice For Getting into the field:** Math and Science background is required: math, physics, and chemistry. Enjoyment of the outdoors is essential. Don't be afraid to accept positions which will provide valuable experience for the future.

**General Comments:** The enjoyment of the profession comes from taking limited scientific information available and predicting or developing a model of what a deposit looks like ultimately, then verifying that hypothesis. Approach the occupation an open mind and you will see some very unique places and things.

**Name:** Alan Romphf

**Occupation:** Division Technical Representative (High Explosives)

**Employed by:** Austin Powder Ltd.

**Education and Training:** Sir Sandford Fleming College – Resources Drilling & Blasting Tech.

Numerous courses relevant to the field.

Over 10 Years of experience blasting, and providing technical support for numerous mines and quarries throughout North America.

**Your Job description:** In charge of critical blast design, blaster training& evaluation, troubleshooting equipment and systems, blasting and other field work, technical support for customers and other Austin Powder representatives, technical reports

**Rewards of Your Job:** Controlling a high energy event.

Working with a diverse group of people.

Working with cutting edge technology and, meshing theory with field practices.

A good mix of field and office work.

**Advice for getting into the field:** Get an education relevant to the field and do well.

Obtain experience with in the mining industry or, running heavy equipment.

To advance, be enthusiastic , open-minded and, willing to learn.

**General Comments:** Never stop learning.

**Name:** Neil Moran

**Occupation:** Quarry Sales and Operations Manager

**Employed by:** Lafarge Canada Inc.

**Education and Training:** I graduated from the Structural Engineering Technology course at Red River College in 2006

**Your Job description:** I am responsible for the Sale of Aggregates out of the Stonewall Quarry, but am also responsible for the Quarry operations. I work with our Crushing Contractor, Earth-movers, Blasters, and Truck Drivers to ensure that we have product on the ground, but also that the product gets to the customers when they need it. I really do get to work in all areas of the operation and that keeps things exciting, there is never any shortage of work to do.

**Rewards of Your Job:** Dealing with and getting to know customers and contractors that I work with every day. I enjoy the satisfaction of knowing that we shipped over 500 loads of aggregate today, or finally figuring outa complicated aggregate gradation that we have been trying to crush. Seeing large projects progress andknowing that I played a big part.

**Advice for getting into the field:** You can't be afraid to work hard for a few years, maybe more, before you get to a manager level in the construction industry, but if you are a dedicated and hard-working employee,your boss will notice. Work a few different jobs and see what you like.

## PART 5 ASSIGNMENT:

Consult your guidance teacher or career councillor. Find out how which courses you need to take to begin a career path in each of the area listed above.

Invite a geologist or engineer working in the aggregate industry to do a class presentation,

# GLOSSARY

IGNEOUS ROCK: rocks formed by intrusions or extrusions of magma from deep within the earth's crust i.e. granite

METAMORPHIC ROCK: rocks formed from other rock under the influence of heat and pressure i.e. marble

SEDIMENTARY ROCK: rock formed from materials deposited by the weathering and erosion of other rocks i.e. sandstone

FOSSILS: remains or an impression of a plant or animal that lived in the past

MANTLE: zone of magna just under the earth's crust

LAVA: molten material just beneath the earth's crust

STRIATIONS: scratches or markings on rock created by abrasion as the glacier moved across the landscape

ESKER: remnant stream bed left behind by meltwater as a glacier receded

OUTWASH PLAIN: rock strewn landscape made of boulders which were carried along by an advancing glacier

BEACH RIDGES: ridge of sand and gravel deposit along the shore of an ancient glacial lake

DELTA: deposit of sand or clay at the mouth of a stream or river when it empties into a larger body of water

SAND BAR: sandy deposit formed by wave action near the shore of an ancient glacial lake

SILICA SAND: known as alluvial sand, it was created by very fine sand particles being carried along by river currents and then deposited when the river entered a larger body of water

KAME: landform made of sand and gravel when meltwater flowed up against a solid wall of solid ice as the glacier receded

DRUMLIN: streamlined deposit of sand and gravel shaped by the glacier's movement

KETTLE: small depression on the landscape created by the melting of a partially buried mass of glacial ice

SAND: small particles of rock from .05 mm to 2.0 mm in size

CORDUROY ROAD: road bed made of logs place parallel to each other over a muddy or swampy base

AGGREGATES: granular material composed of mineral particles such as sand, gravel, and crushed rock

SIEVES: screens used to separate various sizes of aggregate materials

CEMENT: mortar-like powder used in binding aggregates together to make concrete

RECLAMATION: process used to reshape the landscape after the extraction of aggregate or crushed rock material