Lesson 2: Types of Mineral and Geological Resources
The types of mineral and geological resources which could be found on your woodland include:

- Aggregate resources
- Industrial and metallic minerals
- Topsoil, subsoil and peat
- Water resources
- Geoheritage
- Geothermal energy

**Aggregates**

Aggregate resources are the most widely quarried geological resources in the world. They include a broad range of coarse granular material used in construction. The most common sources of aggregate are from surface sand and gravel pits and bedrock quarries. Most sand and gravel extracted from pits in Nova Scotia were originally deposited by ancient rivers and streams or by glaciers as they melted and released materials trapped in the ice. Aggregate is a mainstay of the mineral industry in Nova Scotia and is extensively used by woodland owners for road construction.

Sand and gravel deposits are highly sought-after because their development often requires less-costly permits than those required to open a bedrock aggregate quarry.

However, sand and gravel deposits are restricted to only certain areas of the province and generally do not contain the same quality of material that could be extracted from a bedrock aggregate quarry.

Most aggregate quarries in Nova Scotia supply local projects such as road construction. Nova Scotia is a major exporter of aggregate to PEI, the United States and to Caribbean countries.
The development potential of aggregate resources on your woodlot is dependent on:

- local demand;
- quality of the rock, which can vary;
- distances to markets;
- environmental constraints, and
- proximity to local residents.

Aggregate quality can greatly vary. For some uses, the quality of aggregate is unimportant. In many added-value applications, however, aggregate must meet physical and chemical specifications and standards.

Those familiar with the aggregate industry understand the potential of geological materials in the province, and work with landowners to secure access to these resources. New road construction and road repair require aggregate resources from local sources. If you are interested in selling aggregates from your land, become familiar with the geology under your land.

Provincial demand for aggregate is primarily driven by construction activities in urban centres and by road maintenance. Sand and gravel or crushed aggregate are used to strengthen concrete and asphalt, two common construction materials. Concrete is composed of sand and coarse aggregate bound together with Portland cement. As the most widely used construction material in the world, concrete is used in building residential and commercial structures, including sidewalks, bridges, reservoirs, water mains and sewers.

While woodland road construction is a relatively minor use for aggregate on a provincial scale, it could be important to you. Aggregate is an important constituent in building solid woodland roads and trails. More information on building woodland roads and trails can be found in NSDNR Home Study Module 11: Roads and Trails: Planning it Right from the Start.
Aggregate is also used in many other construction applications. Compacted gravel is used as bedding material for water mainlines, road surfaces and sidewalks. Clear gravel or washed stone has the fine particles rinsed away and is used in drainage applications.

Where erosion threatens coastal properties, large rocks called armour stone, or rip-rap, is used to protect shoreline.

**Industrial and Metallic Minerals**

Minerals provide many of the building blocks for modern culture and society. **Industrial minerals** are a diverse group of materials that contribute greatly to the lifestyle we enjoy. They include all materials extracted from the Earth except for metallic mineral ores, water, fuels, and gemstones. Examples of industrial minerals include limestone for making Portland cement and gypsum for use in wallboards. Some types of clay (for example, kaolin) are used in finishing glossy paper and salt is used to prepare food and keep roads ice-free in winter. Other examples of industrial minerals include anhydrite, limestone, building stone, slate, graphite and silica sand.

In Nova Scotia, industrial minerals contribute immensely to the social, economic and environmental fabrics of the province. Quarry operations provide direct jobs and materials are further processed into value-added products.

Where acidic water threatens fish stocks and aquatic health, limestone is added to some waterways to raise the pH level. A close relative of limestone called dolomite is commonly used in landscaping to lower the acidity in soil.
**Metallic minerals** yield metals such as gold, copper, lead, zinc, iron, tin and tungsten. These metals are extracted and - due to their unique properties - find their way into everyday use.

Gold is a highly valued metal for coins and jewellery. It is found mixed with metallic minerals or can be found alone in lumps (nuggets) in a pure form called native gold. Copper is used in plumbing and electrical wiring, enabling communication by cell phones and the internet. Iron is important in the steel-making industry and lead is used in car batteries. Zinc is applied as a rust preventative to nails and roofing materials. Tin also discourages rust and was once used in canning foods. It is now commonly found in solder and is used in plumbing to join copper pipes together. Tungsten, because of its high heat capacity and hardness, is used as filament on incandescent lightbulbs and to harden other metals in drill bits and saw blades.
All of these metals have been mined in Nova Scotia at some time, and are examples of metallic minerals which could be found under your woodlot. Historical metallic mineral mines are shown in Figure 22.

Industrial minerals and metallic minerals are in high demand because they are important contributors to human life and lifestyles. Some industrial and metallic minerals are rare and very difficult to find. During the past century, an exploration industry has developed to search for minerals around the world, including Nova Scotia.
The Department of Natural Resources maintains a database which contains many documented industrial and metallic mineral occurrences in the province. This information is used by exploration companies searching for mineral deposits. The quest for elusive mineral deposits is a relentless one, and mining companies continue to explore for a wide variety of minerals in the province.

**Figure 23. Sample of an entry in the Mineral Occurrence Database**

**Topsoil, Sub-soil and Peat**

**TOPSOIL**

Topsoil is the place where most of the Earth's land-based biological activity occurs. It consists of a mineral or rock particle component, organic matter (decaying plant or animal material), water and tiny microscopic animals called microorganisms. The mineral component is a combination of sand, silt and clay particles that come from weathered bedrock or glacial till that was left behind after the last ice-age.
Topsoil is considered to be the portion of soil from the surface to the top of the organic poor subsoil. It is important to protect topsoil as much as possible while managing your woodland. NSDNR Home

All the living elements of your woodland require the sustenance provided by the soil (mostly topsoil) in order to survive. Healthy woodlands contain diverse ecosystems which interact with each other. These ecological interactions, which are discussed in Module 7, are responsible for the energy which flows through your woodland. From the tiniest single-celled organisms to the largest trees and mammals – all are connected. These energy pathways are mostly invisible to the human eye and can involve complex biochemical reactions.

The invisible world beneath your feet holds many natural riches. Hidden in the dark folds of the earth, in crevices and cavities and meandering tunnels, life abounds. Between the bedrock and forest floor, the living blanket of soil seethes with activity.

Close to the surface, twigs, leaves and other debris constitute what is called the litter layer. Here, small mammals like voles and shrews hunt for insects, centipedes and other prey. Their bustling activity mixes and crushes the debris of the litter layer, breaking it into finer fragments which sift deep into the forest floor. Predatory spiders stalk this jungle of debris, seeking insects and millipedes and leaving their shrunken carcasses to add to the organic material building up in this zone. Close to the surface, oxygen is freely available and aids in decomposing the organic matter quickly.

Rain and snowmelt aids in the downward movement of fine pieces of debris. The smallest particles travel farthest, and build up in greater quantities as the litter layer decomposes over decades and centuries. Centipedes and insects shuffle among the fine particles of litter which have accumulated only a few centimeters from the surface. Moisture levels are higher here, and there is less oxygen to assist in decomposition. In this area, called the fermentation layer, organic compounds break down more slowly, resulting in rich, dark material similar in texture to peat moss.

As insects, centipedes, millipedes and other organisms move about in this dark zone, particles of mineral soil become mixed with organic material. Earthworms migrate to the soil surface during warm moist weather, bringing mineral soil with them and churning it into this rich band, called the humus layer.

If an intact forest cover is present, organic matter constantly rains down from tree canopies and ground vegetation. It collects in the upper levels of the soil, building a deep fertile substrate. Plant seeds may germinate and take root in these productive sites, contributing to cycles of regeneration which may persist indefinitely.

In the past, top-soil has been stripped from agricultural areas for use in housing subdivisions and for gardening. To conserve top-soil, some companies manufacture soils to lessen the impact of topsoil removal.

**SUB-SOIL**

Sub-soil, or till, is the sedimentary material between the top-soil and the bedrock. It originated from glacier deposits and from weathered bedrock. These materials are quite diverse physically and chemically, and are commonly used as fill for road building and construction purposes. Materials with a high concentration of sand content are suited to backfilling around buildings because water will readily drain away from the foundation. Sandy sub-soil is also used extensively in landscaping.

![Figure 24. Coastal exposure of soil and sub-soil lying on bedrock.](image)
In some areas of the province, the sub-soil contains a high proportion of clay. Because they are much smaller than sand, clay particles are the most abundant particles in soils. These materials are very fine-grained, difficult to shovel and, when wet, slippery and feel greasy to the touch.

Clay-rich sub-soil is very useful in instances where water flow must be restricted or diverted. These applications include lining artificial ponds or dams with clay till to retain water, and capping waste landfills with clay to divert water away from the site. Because diversion reduces the volume of water requiring treatment, operational costs are reduced.

Clay-rich sub-soil readily holds water, causing it to expand and shrink depending on moisture content. These properties limit clay sub-soil as a useful material for backfill and in woodland road construction. When wet, clay soil softens, becomes slippery, and is easily eroded, and hence increased road maintenance. As a woodland owner, if you use soils high in clay content for road construction, you should ensure the road is well drained and used only during dry weather.

As discussed earlier, surficial geology maps show the distribution of surface sediments deposited by glaciers and water processes. The Surficial Geology Map of Nova Scotia is a compilation of numerous regional and local mapping initiatives and explains the relationships between the surficial units in the province and potential economic uses. It is a valuable resource for learning about these useful materials.
PEAT

Peat is partially decomposed vegetation that accumulates in bogs and wetlands. On land, where moisture is limited, organic material decomposes to humus. In a waterlogged environment, organic material is transformed into peat over centuries.

Peat deposits contain a mixture of plant species which grow in wetlands, including sphagnum moss (also called peat moss), shrubs and sedges.
Common in Nova Scotia, peat is a valuable resource used in the gardening and landscaping industries. It is primarily used as a soil conditioner, both aerating the soil and increasing its capacity to hold water. Nova Scotia exports most of its peat to the United States and Asia. One operation in the Annapolis Valley has been extracting peat since 1949.

During the 1980s the Nova Scotia Department of Mines and Energy conducted a province-wide inventory of peat resources which included both Crown land and private land. Thirty deposits with good potential for commercial peat development were catalogued as well as numerous other deposits that had not been inventoried.

Approximately 160,000 ha (395,200 acres) of peat resources are considered to exist in Nova Scotia. The greatest concentration of these is in the southwestern region of the province.

If you have peat resources and are interested in developing it, contact the Department of Natural Resources.

The geology of a site can influence the quality and quantity of water which is present. Some geological units produce good quality and/or high volumes of water, while others produce either poor quality or low volume of water.

Water supports many businesses and industries in Nova Scotia. These include agricultural farms, mineral resource companies, land-based aquaculture and others. Provincial water resources also allow many recreational and tourism activities such as swimming, boating and sport fishing.

Water quality and quantity is very important to woodland owners. Wildlife thrives where clean, cool water is available. Aquatic plants and animals require water which is uncontaminated by chemical runoff.

During fire season, a ready supply of water should be accessible on or near your woodland. See NSDNR Home Study Module 16: Wildfire and Your Woodland for more information.

Water Resources

Water is essential to the survival of plants and animals and to the maintenance of the ecosystems and habitats where they live. The health and biodiversity of ecosystems greatly influences water quality and quantity.

In Nova Scotia, approximately 40 per cent of the population extracts their drinking water from individual wells. The remainder rely on municipal or public water supplies from wells, lakes and rivers.
It is important to consider that wetlands have a vital role in the conservation of water quality and quantity. Wetlands regulate the amount of water on the landscape by acting as buffers during potential flood events and seasons. The organic matter in wetlands works as efficient filters to remove excess silt and contaminants from water.

Forests, too, protect water resources. Intact tree and shrub canopies help maintain cool water temperatures for aquatic organisms, including fish. Healthy root systems absorb excess moisture, reducing runoff and storing water for dry seasons.

The Department of Natural Resources maintains a water resources database that contains information on water well locations, well depths, well geology logs, well pumping rates and in some cases, well water chemistry. This database, along with a map showing watershed boundaries is available as a map service on the DNR website at fletcher.novascotia.ca/DNRViewer/?viewer=Groundwater.

Geoheritage

Since the mid-1800s, ecologically important and sensitive areas have been conserved and protected. In contrast, recognition of significant geoheritage sites only began in the early 1990s.

Despite its slow acknowledgement, geoheritage has quickly evolved worldwide to facilitate the conservation of geologically significant areas and sites. Geoheritage highlights our close connection with Earth.

A billion years of geological history has endowed Nova Scotia with many unique geological features and globally significant sites. Beginning with Mi’kmaq culture several millennia ago, the connection to our geological heritage has unfolded over time, revealing a rich tapestry of human settlement and industry.

Two types of geoheritage resources are recognized in Nova Scotia:

1 Natural geoheritage sites are outstanding examples of Earth’s history in rock and early life in fossils;

2 Cultural geoheritage sites are locations at which Mi’kmaq and Nova Scotians have directly interacted with the surrounding geology. These include sacred sites, memorials and museums.

The globally significant UNESCO World Heritage Site at Joggins Fossil Cliffs was the result of geoheritage research by the Department of Natural Resources, Geoscience and Mines Branch, in 2008.

Figure 30. Joggins Fossil Cliffs and the UNESCO World Heritage Site Monument.
Geothermal Energy

As technologies which extract heat from the Earth have developed over the past two decades, geothermal energy has gained wider use among homeowners and commercial operators. Systems which obtain heat energy from the ground can be of several different designs, including the following:

- Loops of pipe are laid underground or placed in a water body, and liquid that will not freeze is circulated through the pipe. Heat is extracted from the warmer liquid which returns from underground.
- Two wells are drilled. One well is used to extract water and heat from underground and the other is to return water underground.
- A third technology, which could be suited to district heating projects, involves the extraction of heat from the water in abandoned mines. The water in disused underground tunnels remains at a fairly constant temperature through the year, and temperature rises about 1 to 3 degrees C for each 100 metres of depth. These conditions create opportunities to extract heat energy from abandoned mines at some locations in the province. Water or other fluids are circulated through pipes in the old tunnels and heat energy can be extracted as this fluid gains heat from the underground water.
### Quiz 2

1. Aggregate resources can be extracted from bedrock or surface deposits left by glaciers and rivers.  
   - True  
   - False

2. Most aggregate production is from sand and gravel pits.  
   - True  
   - False

3. Aggregates are important components of concrete.  
   - True  
   - False

4. Sub-soils containing a high proportion of clay make good road construction materials.  
   - True  
   - False

5. Peat is comprised of decomposed sphagnum moss, shrubs and other wetland plants.  
   - True  
   - False

6. Commercial peat production is mostly restricted to Cape Breton.  
   - True  
   - False

7. The fossil cliffs at Joggins are good examples of geoheritage sites.  
   - True  
   - False

8. Gold, copper, tin and zinc have all been mined in Nova Scotia.  
   - True  
   - False

9. With modern recycling, we no longer need to mine metallic minerals.  
   - True  
   - False

10. Forests help protect water resources.  
    - True  
    - False
Case Study – Part 1

Mattie was proud of her woodland. Together with her son Thomas, they managed 122 hectares (300 acres) of forest land in Guysborough County, N.S. One side of the lot was bounded by a long, narrow lake which was ideal for canoeing when the wind wasn’t blowing from the northeast.

She was particularly fond of the family cabin, which was nestled in a small cove of the lake. Many late spring afternoons were spent with a book, listening for the loon that haunted the south end of the lake. Mattie glimpsed the loon, with three youngsters in tow, just before dark on most evenings. She suspected that the loon had a nest in that area.

Thomas enjoyed working in the woodland, spending a few weekends each year hauling fuelwood from a large stand of sugar maple and yellow birch. With the old tractor and a loader-trailer, he could bring enough wood roadside to keep their house in Antigonish supplied with winter warmth. He cut shorter wood to feed the old woodstove in the cabin.

As a graduate of the forestry program at the Nova Scotia Community College in Port Hawkesbury, Thomas was keen to manage the family woodland in the best possible way. He was very interested in the concept of selection harvesting, which maintained at least three age classes of trees in a stand. There were some good quality hardwood stands which he thought were well suited to this stewardship approach.

Thomas was careful not to harvest more than he figured the woodland would grow, something which his grandfather had taught him, and had called it sustainable forestry. This idea had stuck with Thomas, and he was anxious to attempt it on the family woodland.

During the past year, Thomas became interested in identifying forest plants. Beneath the hardwood stands he had always been impressed with the abundance of spring beauty, yellow clintonia and trout lily. He had once found nodding trillium - and knew these plants were uncommon. Thomas also became aware of the importance of soils in maintaining healthy woodland.

During his forestry training, Thomas was introduced to Forest Ecosystem Classification, a method of classifying trees, ground vegetation and soils. The data was then used to better understand the types of forestry work which could be carried out on a forest site.

Thomas also read a recent NSDNR publication A Field Guide to Forest Biodiversity Stewardship. In this book he learned that there was an immense diversity of life in Nova Scotia forests, and many plants and animals require special habitats to survive. The Guide recommended certain stewardship practices according to stand and tree features, wildlife habitat and other site characteristics.

To Thomas, the soil which supported woodland growth was fascinating. The idea

To Thomas, the soil which supported woodland growth was fascinating. The idea
that a living layer existed beneath the forest floor - complete with insects, fungi and earthworms – held his imagination captive. He was entranced with the knowledge that trees provided organic matter to the soil which, in turn, provided nutrients and moisture to the world above.

Thomas was always curious about the small outcrops of cream-white rock which jutted in a few places from the hillside where he often cut hardwood. He knew these rocks were quartz, but considered them a nuisance when trying to pick a route for the tractor and trailer’s slow progress.

Thomas knew that a woodland road was essential for accessing the property, but roads were expensive to build and he felt he didn’t have enough income from the sale of wood to justify the cost of road construction.

Thomas was particularly interested in an area where a small stream ambled through the maple and birch trees, joining a larger stream near the bottom of the hill. In several places near the junction of the streams, old mounds of earth were overgrown by spruce. Mine waste piles, his grandfather had called them, and said that folks had looked for gold in those places many years ago. “Never found much of anything,” he had scoffed.

Mattie really didn’t remember those days but she knew specks of gold no larger than a pinhead had been found on an adjacent property many years ago. The find had been kept quiet for a few years by the owner, but word had finally gotten out. The hills soon swarmed with men, pickaxes and shovels in hand. They had burrowed and sweated in the heat of that summer - but had not found much of anything - or so the story went.