A supplement to the student's answer key
on page 20 of the full book

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A Sedimentary Sandwich: Pages 2 & 3

Sedimentary rock – rock that has formed from sediments such as sand, mud, and small pieces of rocks. Over long periods of time, these small pieces of debris are compressed (squeezed) as they are buried under more and more layers of sediment that pile up on top of them. Sedimentary rocks are deposited as strata, or layers. Generally, the deeper the layers, the older the rock. The tectonic process pushes the strata to the Earth's surface as rocks or strata are broken by natural forces within the Earth's crust.

The organic materials trapped within the sediment become more deeply buried; heat and pressure transform them into solid, liquid, or gaseous hydrocarbons (compounds containing only hydrogen and carbon) known as fossil fuels – coal, crude oil, or natural gas. Oil (a mixture of liquid hydrocarbons) is typically derived from marine plants and animals that have been "cooked" for at least one million years at a temperature between 50° and 150° Celsius. Natural gas can be formed from almost any marine or terrestrial organic materials under a wide variety of temperatures and pressures.

Most of the world's petroleum (generic term for hydrocarbons, including crude oil, natural gas liquids, and natural gas products) has been found trapped in porous rock under relatively impermeable formations. These reservoirs are often long distances away from the original source.

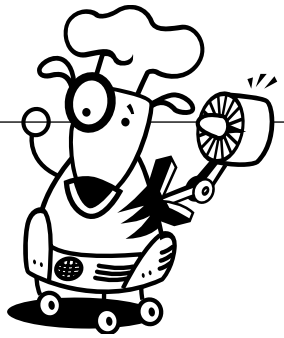
Due to the force of gravity and the pressure created by the overlying rock layers, oil and natural gas seldom stay in the source rock in which they are formed. Instead, they move through the underground layers of sedimentary rocks until they either escape at the surface or are trapped by a barrier of less permeable rock.

A seep occurs when hydrocarbons migrate to the Earth's surface. Over millions of years, huge amounts of these hydrocarbons have escaped into the atmosphere. Flowing water can also wash away hydrocarbons. Sometimes only the lighter, more volatile compounds are removed, leaving behind reservoirs of heavier types of crude oil.

Oil is only found in sedimentary formations because an oil trap requires three components:

- porous reservoir rock to accumulate the oil and gas – typically sandstone, limestone, and dolomite;
- overlying impermeable rock to prevent the oil and gas from escaping; and
- a source for the oil and gas, typically black, waxy shale.

Oil sands – Conventional crude oil flows naturally or is pumped from the ground, but oil sands must be mined or recovered in situ, which may involve steam and solvent injection. Deposits close to the surface are mined while those deeper than 75 require in situ recovery. Most current in situ bitumen and heavy oil production comes from deposits more than 400 metres below the surface.



Answer Key

A Sedimentary Sandwich: Page 2

Read to learn about the different earth layers.

A Sedimentary Sandwich: Page 3

Colour your own rock layers.

DOODLEBUGGING: PAGE 4

Students will be introduced to some geophysical terminology and processes while completing this puzzle.

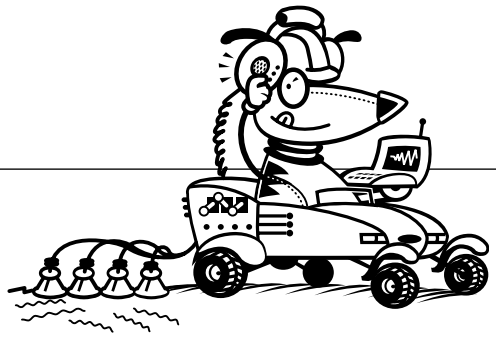
Seismic exploration – (doodlebugging) a process by which geophones are used to record shock waves set off by a series of controlled explosions. The time interval between the explosion and the shock wave helps geophysicists determine the approximate make-up of the subsurface structure and determine if structural oil traps exist.

Jughustler – member of a seismic crew who operates the geophones.

Geophones – sensitive vibration-detecting instruments used in conducting seismic surveys.

Rig – a structure used to carry the equipment needed for exploratory drilling.

Shotholes – holes created by small explosions used to produce shock waves during a seismic survey.



ANSWER KEY

DOODLEBUGGING: PAGE 4

"Working on a seismic exploration
crew is dynamite! It's a real charge!"

LANDMEN AND ENGINEERS: PAGE 5

Landmen – oil company employees or contractors whose primary duties are managing the company's relations with landowners. These duties include

- acquiring land for the oil company to explore;
- obtaining mineral rights from the Province of Alberta (Ministry of Energy); and
- communicating potential oil development plans with the landowner.

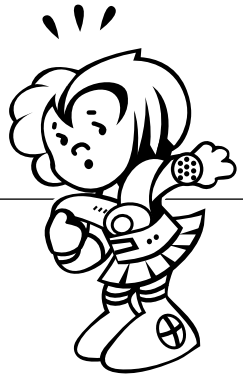
If the ERCB approves the company's development application, the company may commence drilling. Since landowners do not usually own the subsurface mineral rights (they are owned by the Province of Alberta), landowners will not become rich if oil is discovered on their land. However, the oil company will compensate the landowner for the loss of the use of land on a case-by-case basis.

Petroleum engineers – search for reservoirs containing oil or natural gas. Once these are discovered, petroleum engineers work with geologists and other specialists to understand the geologic formation and properties of the rock containing the reservoir, determine the drilling methods to be used, and monitor drilling and production operations.

Chemical engineers – develop processes, design equipment, and provide technical and management services for petrochemical and gas plants that convert raw materials into a wide range of end products (chemicals, pharmaceuticals, food products, fuels, plastics, metals).

Mechanical engineers – research, design, evaluate, install, operate and maintain mechanical products, equipment, systems, and processes.

Electrical engineers – design, construct, operate, evaluate, test, and monitor the performance of electrical equipment, components, and systems.



ANSWER KEY

LANDMEN AND ENGINEERS: PAGE 5

If you drilled down from rig:
A = 1,000 barrels of oil.
B = Sorry, no oil.
C = Wow! 100,000 barrels of oil!

DRILLING: PAGE 6

Derrick – the extended pyramid of latticed steel mounted over the borehole for drilling and well-servicing purposes.

Crown block – pulley system used for raising and lowering drilling tools, consists of either a rotary or a cable rod, and is housed at the top of a derrick.

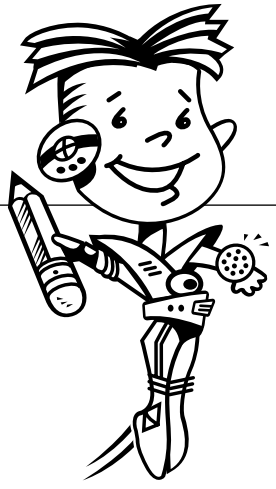
Monkey board – the platform on which the "monkey" (derrick worker) stands while working.

Blowout preventer – a casinghead control designed to prevent the uncontrolled flow of fluids from the well bore by closing around the drill pipe or completely sealing the hole in the absence of a drill pipe.

Travelling block – the moving pulley system used in conjunction with the (fixed) crown block for raising and lowering the drill string, casing, etc.

Draw works – the name for the hoisting drum, shaft, clutches, and other operating machinery used in the drilling of a well. The draw works are situated at one side of the derrick floor connected to a power source and serve as a power control centre for the hoisting gear and usually for the rotary elements of the drill column.

Doghouse – the small shed near the derrick where the driller and the tool dressers keep their work clothes and gear.



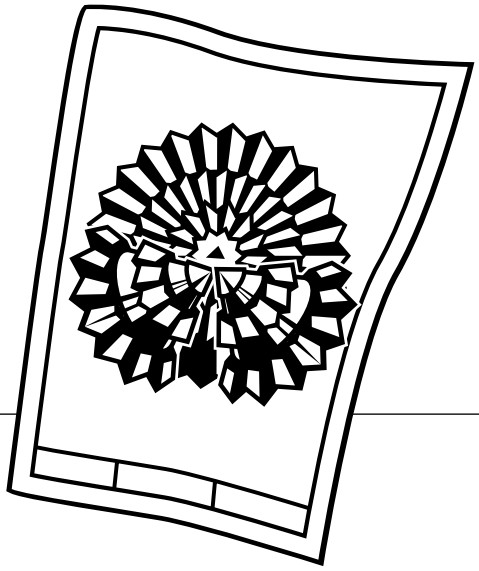
ANSWER KEY

DRILLING: PAGE 6

(3) CROWN BLOCK
(1) TRAVELLING BLOCK
(5) MONKEY BOARD
(6) DRAW WORKS
(2) BLOWOUT PREVENTER
(4) DOG HOUSE

WHAT IS IT?: PAGE 7

Drilling bit – the bit used to drill after the well is "spudded" (initially drilled). The surface of the earth does not normally require regular drilling tools, as it is not as hard to drill through as subsurface strata; normally a special spudding bit will be used initially and then substituted for by regular drill bits when the drill reaches a rock formation level.



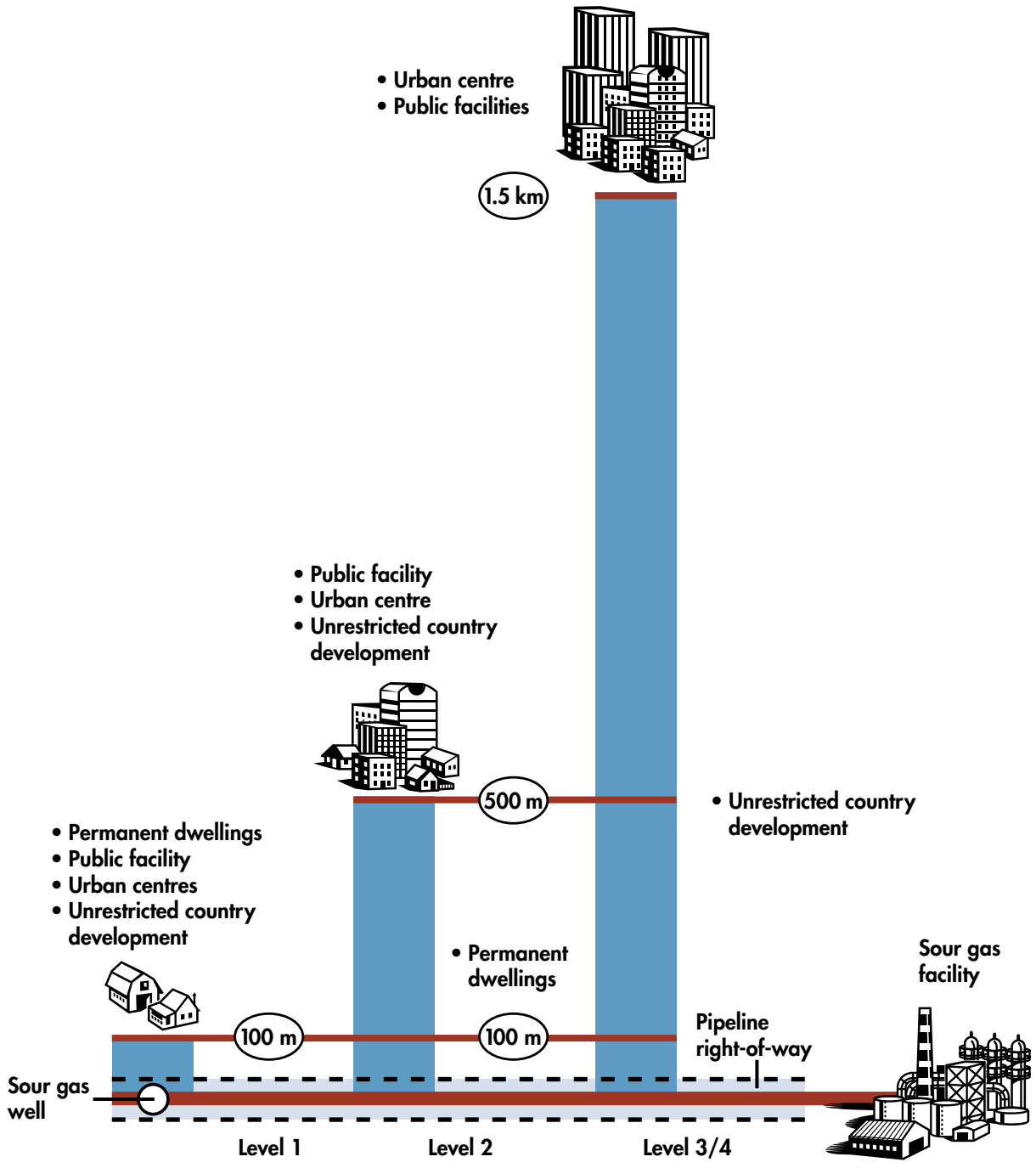
ANSWER KEY

WHAT IS IT?: PAGE 7

It is a picture of a drill bit.

PIPELINES: PAGES 8 & 9

A setback is the minimum distance that must be maintained between any energy facility (for example, a drilling or producing well, a pipeline, or a gas plant) and a dwelling, rural housing development, urban centre, or public facility. Setbacks vary according to the type of development and whether the energy facility contains sour gas.

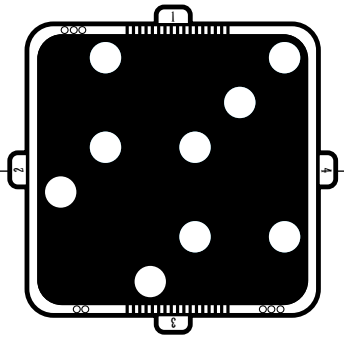


SOUR GAS: PAGE 10

Sour gas is a type of natural gas made up of carbon and hydrogen molecules. Sour gas is defined as any type of natural gas with more than 1 per cent hydrogen sulphide (H_2S).

H_2S is a toxic gas formed by the breakdown of organic materials. It is found in natural gas, oil, sewage, swamps, and stockyards and in the processing of pulp and paper. The gas is colourless, but you would recognize its "rotten egg" smell even at low concentrations.

Sour gas represents about one-third of natural gas production in Alberta. It can be lethal for humans and animals if they are directly exposed. For this reason, the ERCB places sour gas plants under the strictest safety and monitoring standards.



ANSWER KEY

SOUR GAS: PAGE 10

"About one-third of all gas produced is sour!"

WHAT ABOUT SOUR GAS & SAFETY?: PAGE 11

A critical sour gas well is a well that could potentially release large quantities of H_2S, causing significant harm to nearby people. A critical sour gas well requires a detailed drilling plan that addresses all aspects of the proposed operation. The ERCB must review and approve the plan before licensing a critical well. Once a well is classified as critical, drilling preparations must meet all the operational and safety-related requirements set out by the ERCB. A drilling plan for a critical well includes

- well design;
- equipment;
- drilling procedures;
- training and supervision;
- inspections; and
- emergency response planning.

Every company drilling or operating critical sour wells is required to have a site-specific emergency response plan (ERP). If you live in an area where sour gas drilling is likely, be assured that no company will receive permission from the ERCB to drill a critical sour well until it has prepared an ERP tailored to the specific circumstances of that well, with detailed attention to such things as weather patterns, terrain, nearness of people, and anticipated release of H_2S in the event of an accident.

ANSWER KEY

WHAT ABOUT SOUR GAS AND SAFETY?: PAGE 11

1. Special Training
2. Blowout Preventers
3. Inspections
4. Automatic Shutoff
5. Gas Emissions
6. Regulates

A FIELD DAY FOR SAFETY: PAGE 12

Geologist – a person trained in the study of the Earth's crust. A petroleum geologist focuses primarily on sedimentary rocks, which contain most of the world's oil.

Petroleum engineer – searches for reservoirs containing oil or natural gas. Once these are discovered, petroleum engineers work with geologists and other specialists to understand the geologic formation and properties of the rock containing the reservoir, determine the drilling methods to be used, and monitor drilling and production operations.

Driller – the chief of a crew that drills an oil or gas well. Wells are typically drilled continuously on three 8-hour shifts called tours. The driller is responsible for carrying out the orders of the geologist or supervisor of the well.

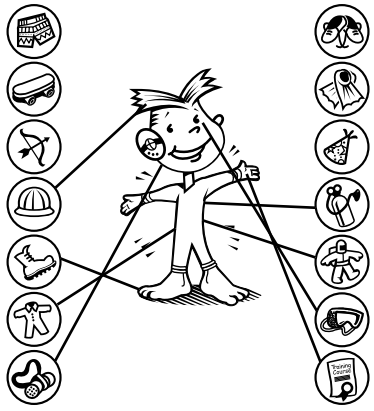
Safety officer – ensures that equipment meets safety standards and employees adhere to safety procedures.

Rig manager – the overall supervisor of a rig.

Land surveyor – a person who studies, classifies, and measures rock formation outcrops. The surveyor maps and collects data to produce a geological picture of underground formations.

ANSWER KEY

A FIELD DAY FOR SAFETY: PAGE 12



Hardhat
Safety boots
Coveralls
Breathing mask
Oxygen bottle
Flame-resistant clothing
Goggles
Training certificates

ERCB Field Trip: Pages 14 & 15

The ERCB is responsible for inspecting energy facilities and enforcing the standards, specifications, and conditions set out in licences and approvals. Various government departments also have legislated mandates to inspect energy facilities.

For example, **Alberta Environment** enforces clean air and clean water regulations, and **Alberta Sustainable Resource Development** safeguards fish, wildlife, forests, and public lands. ERCB staff carry out inspections on Alberta's oil, natural gas, oil sands, coal, pipeline, and electric facilities. Routine inspections include:

- nonscheduled inspections based on reports or complaints from the public;
- inspections of natural gas processing plants, particularly sour gas plants;
- environmental inspections to ensure that procedures and equipment are in use to minimize environmental impacts;
- inspection of coal mines and oil sands mines to ensure that the facilities are safe, follow environmental guidelines, and have efficient resource production and conservation;
- spot checks during the construction and testing of pipelines;
- periodic inspections of operating pipelines;
- inspections of oil and natural gas batteries (the equipment for collecting, separating, and measuring oil and gas); and
- inspections of power plants and transmission facilities.

There are over 100 ERCB inspectors based in the ERCB Field Centres throughout Alberta.

ERCB inspectors are backed by law through the powers granted by the statutes under which the ERCB operates. They have the authority to shut in a well or shut down a facility if it poses a threat to public safety.

Inspections are made at selected stages of energy development, depending on the type of facility and its previous inspection history.

ERCB field inspections are prioritized based on the weighting of three key criteria known as **OSI**: **o**perator history, site **s**ensitivity, and **i**nherent risk of the facility or operation.

- A review of an operator's compliance history allows ERCB inspectors to focus on operators with an unacceptable level of unsatisfactory inspections. The ERCB considers any company with three or more inspections that revealed unsatisfactory items to have a poor inspection record.
- Sensitivity of the area where the operation is taking place is also reviewed and includes items such as proximity to the public or bodies of water and areas where there has previously been significant public concern regarding oil and gas operations.
- The risk of a facility or operation is determined by reviewing specific technical details about the facility, such as well depth, complexity of the operation, and whether the facility is sweet or sour.

Inspectors check to ensure that companies are following sound operating practices and meeting ERCB requirements set out in its regulations and in the facility's licence. ERCB inspectors have the expertise to explain regulations and analyze procedures with the technical staff operating the energy facility being inspected.

Depending on how serious a problem is, ERCB inspectors may give the operator time to correct unsatisfactory items; however, if a regulation is seriously disobeyed or there is any danger to people or the environment, the facility is immediately shut down.

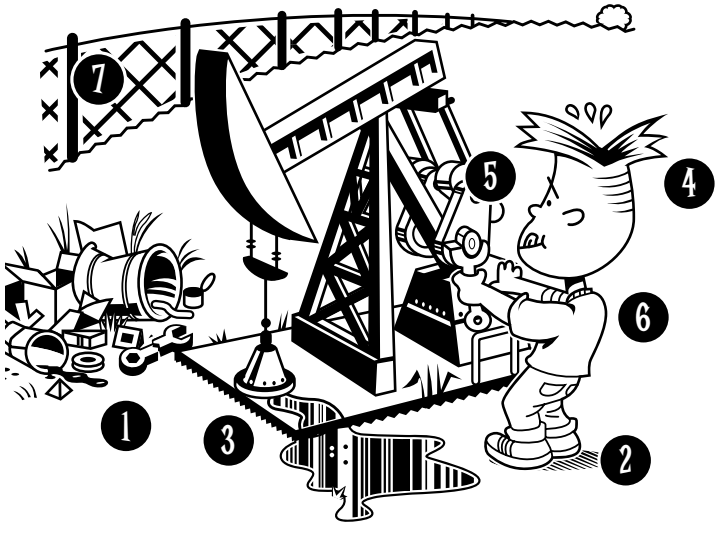
Furthermore, if a situation is considered dangerous, the well or facility is shut down immediately. Also, if an operator is unable or unwilling to correct a problem within a specified period of time, the ERCB will shut down the facility. The operator may be given a short time extension in which to correct the situation, as occasionally there may be delays in obtaining the necessary equipment to correct a problem. However, the ERCB must be satisfied that safety is not a concern and that the operator is making every effort to meet the requirements.

Answer Key

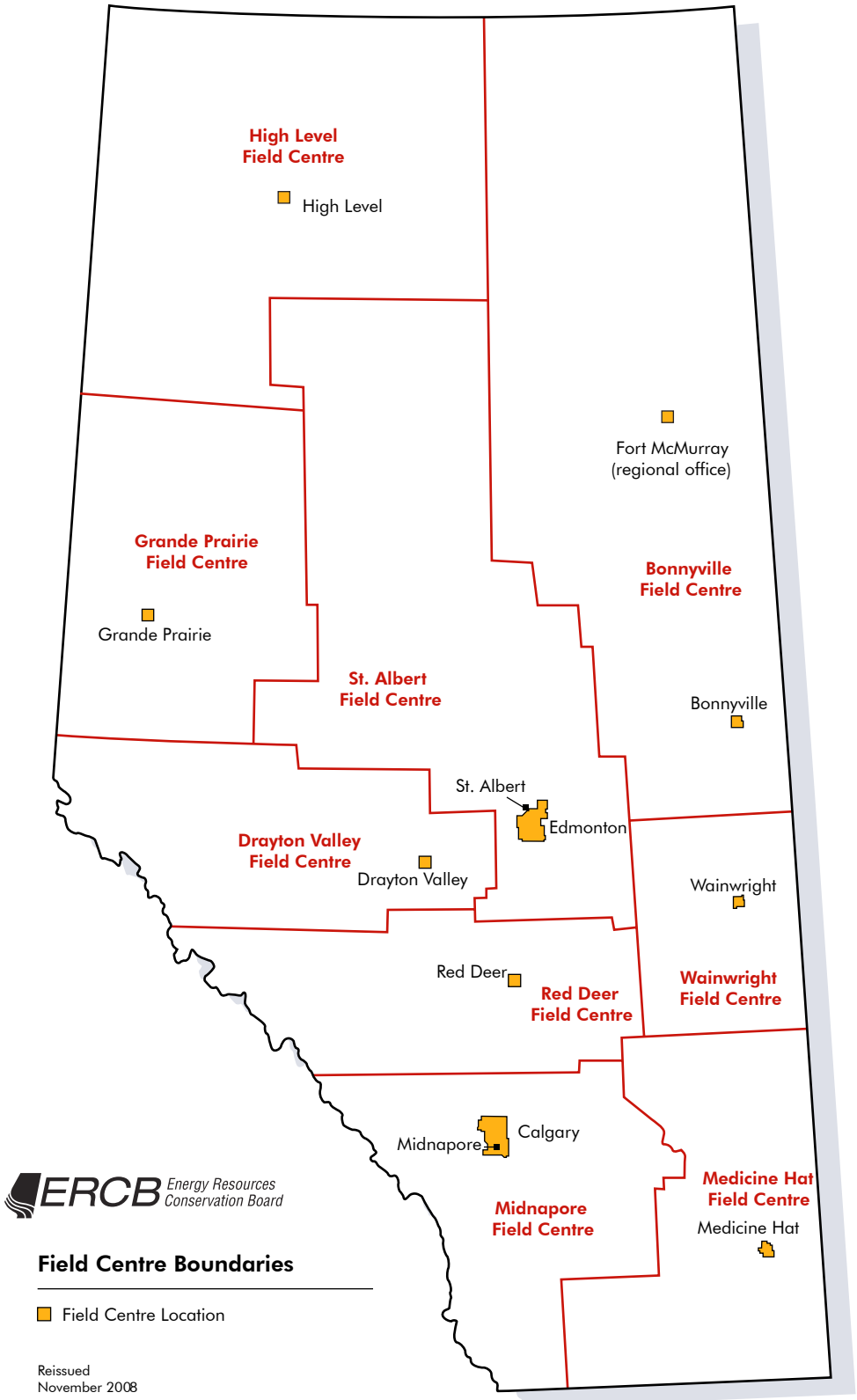
Field Trip: Page 14 - Correct answers are:

1. A
2. A
3. D
4. D
5. D
6. D
7. D

Field Trip: Page 15



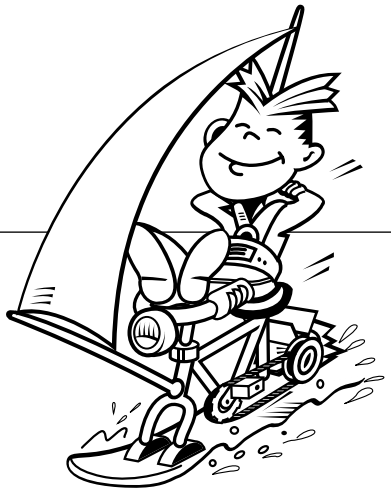
1. Trash
2. No Safety Boots
3. Oil Leak
4. No Hardhat
5. No Safety Goggles
6. No Coveralls
7. No Sign



The Conservation Kid: Page 18

10 ways to conserve energy:

1. Turn off appliances when you are not using them.
2. Thaw frozen foods before cooking.
3. Wash only full laundry loads.
4. Walk; ride in carpools; ride a bike; observe speed limits; keep car in good running condition.
5. Take shorter showers and avoid long baths.
6. Keep doors and windows closed when using heat or air conditioning.
7. Set the refrigerator at 3°C and the freezer at -18°C for optimum efficiency and food safety.
8. Close fireplace flue when not in use.
9. Close draperies at night, or against the hot sun in the summer or cold temperatures in the winter.
10. Do not use several heavy appliances at the same time; turn off appliances when not in use.



Answer Key

The Conservation Kid: Page 18

2. "On short trips, ride your bike or walk."
3. "Take the bus instead of asking for a ride."
4. "Learn to windsurf, not to waterski!"

KIDS AND TEACHERS!

LOOK FOR THE INTERACTIVE ONLINE VERSIONS OF:

- SEDIMENTARY SANDWICH
- LANDMEN AND ENGINEERS
- PLOTTING A PIPELINE'S FUTURE
- SOUR GAS - DECODING THE FACTS
- A FIELD DAY FOR SAFETY

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