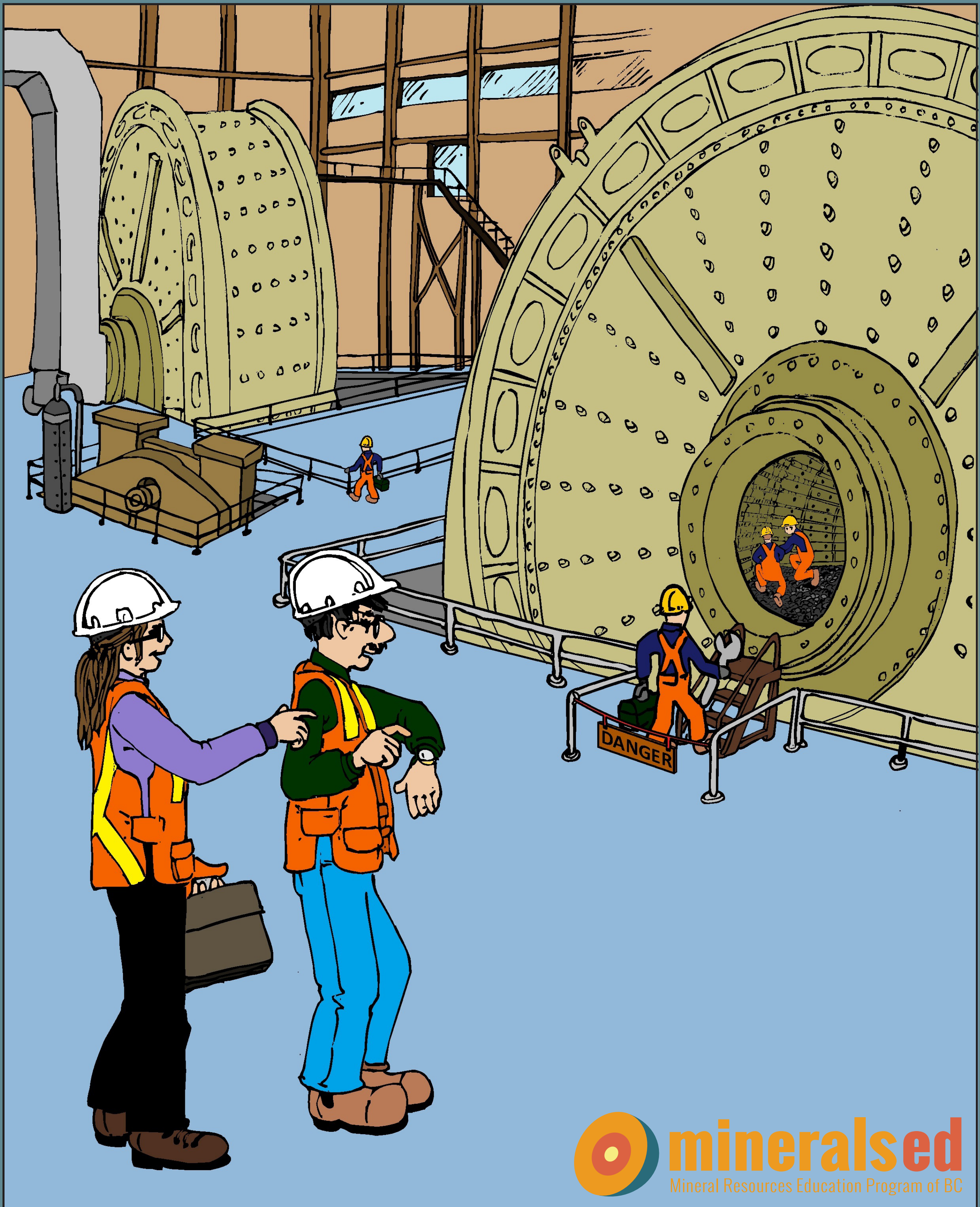
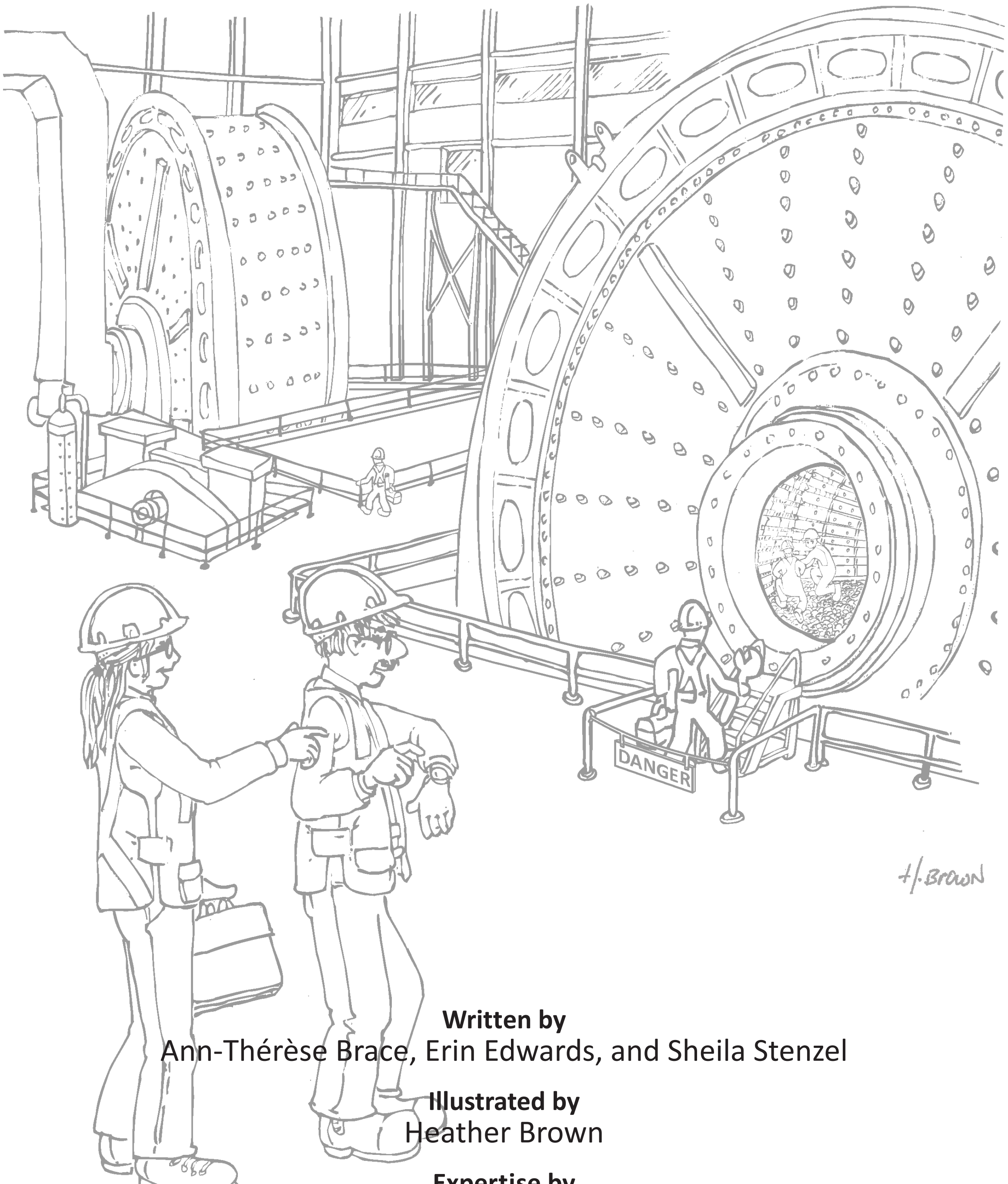
I am a
Mining Engineer



I am a
Mining Engineer



Written by
Ann-Thérèse Brace, Erin Edwards, and Sheila Stenzel

Illustrated by
Heather Brown

Expertise by
Tom Broddy and Julia Gartley, Mining Engineers with Taseko Mines Ltd.

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Preface

Engineers involved in mining activities are skilled professionals who are experts in designing, building, maintaining, and improving mining operations. They are knowledgeable of all the sciences and math associated with these activities. They have backgrounds in all other engineering fields (mechanical, civil, structural, and electrical) and metallurgy, and know how to use many special computer applications. These mining engineers are detailed planners, efficiency experts, and front line problem solvers, who work as part of the operations team to make the mine productive and safe for workers and the environment.

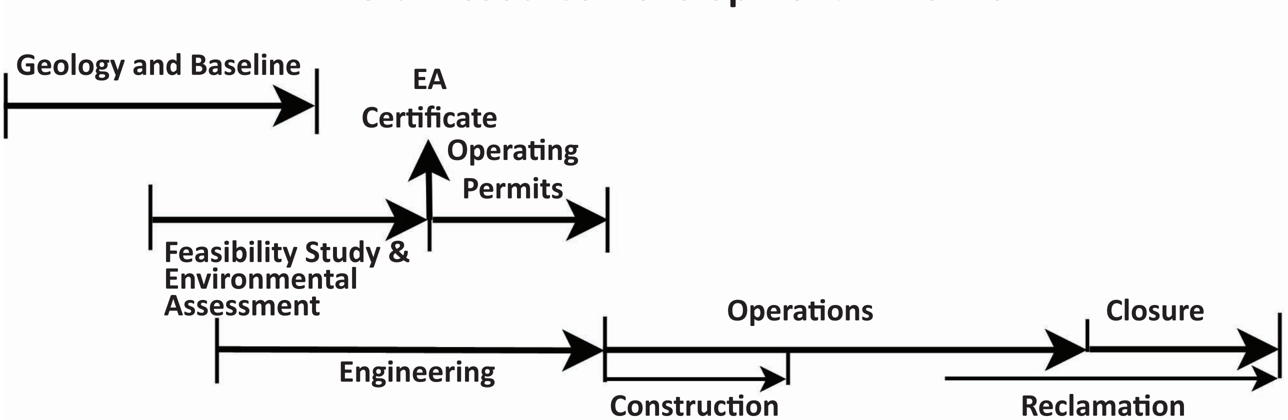
This is a story that focuses on the work of mining engineers at different stages in mine development, from the feasibility study to engineering and construction, to operations and reclamation.

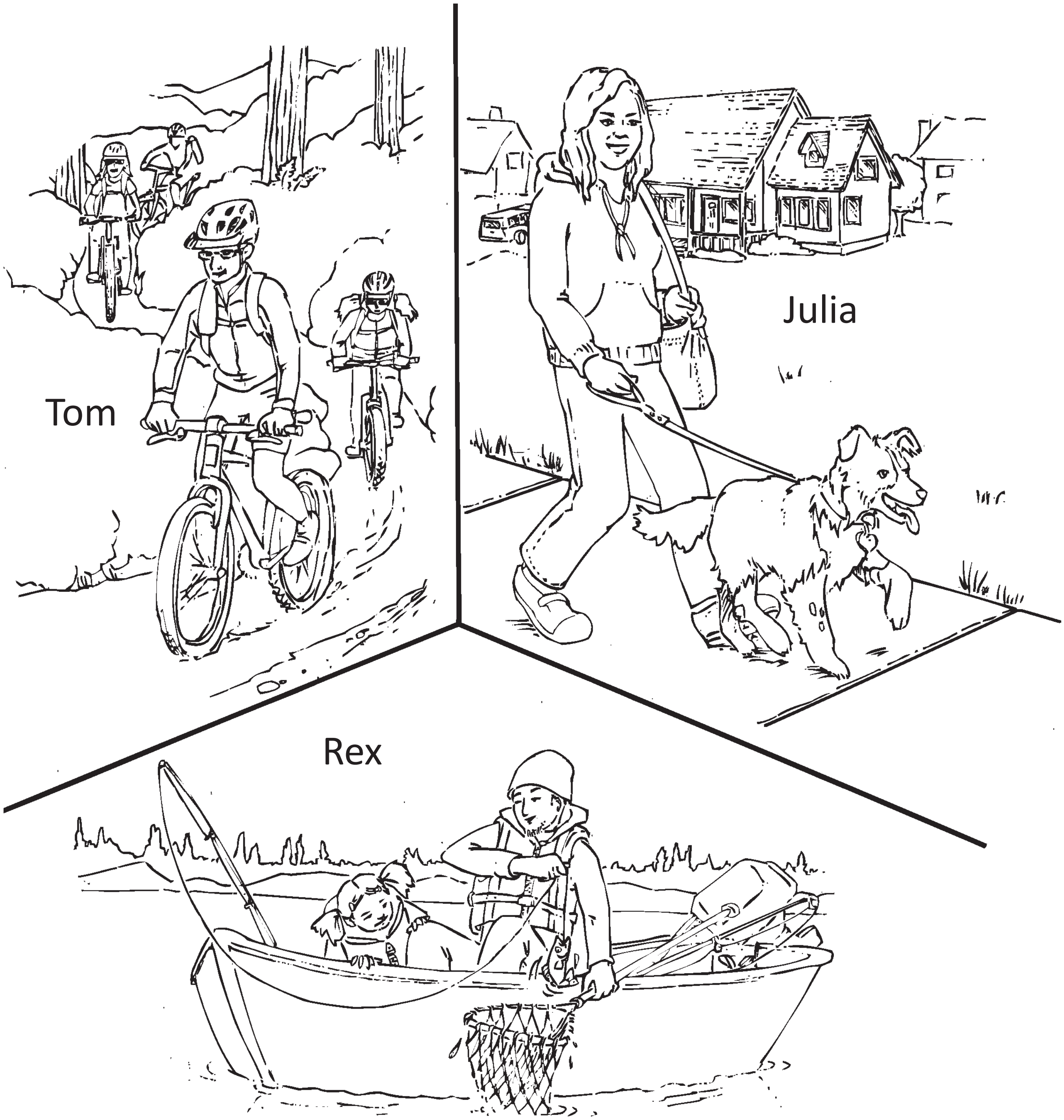
Mining engineers are among the first professionals consulted when an ore body has been discovered. They apply their know-how to determine if it is feasible to mine the deposit safely and make a profit. If so, then mining engineers develop the mine site plans and work with other engineers and all the various trades to build the large and complex infrastructure that make up a modern mine. When in operation they oversee how the mine develops over time, all the technical details to make the processes efficient, and how waste will be stored and treated.

Mining engineers depicted in our story encompass many types of engineering experts. At a real mine the person who designs the mine and manages pit operations is a mining engineer. The person who manages and optimizes mill operations would be the mineral process engineer. A person who ensures maximum recovery in a metal refinery at a mine would be a metallurgical engineer. And one responsible for designing and managing waste rock on site would be an environmental engineer.

It is important to know that mining engineers are key to producing the mineral resources we use every day in a manner that is most safe and most efficient and impacts our natural environment in as small a way as possible.

Mineral Resource Development Timeline

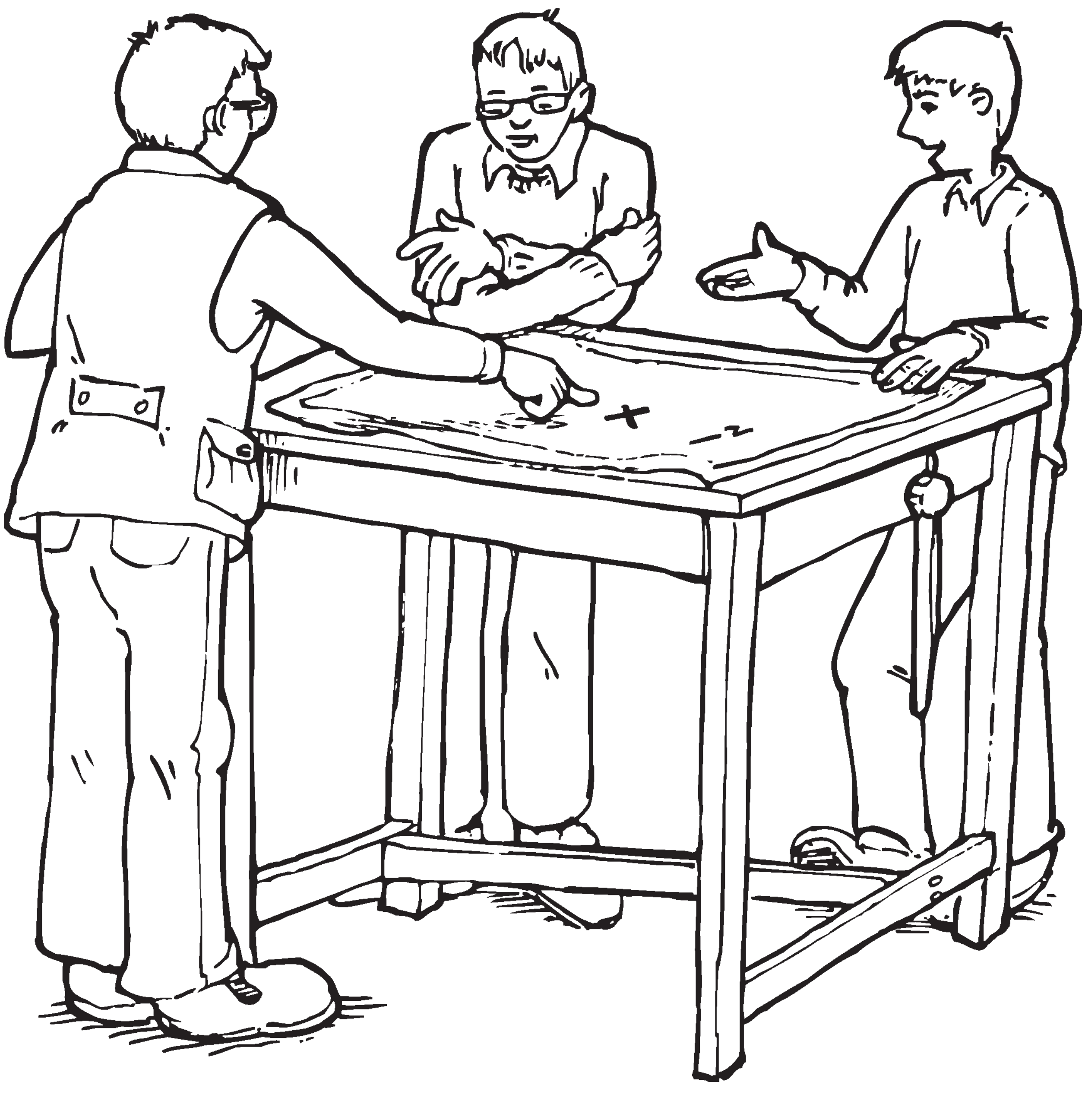




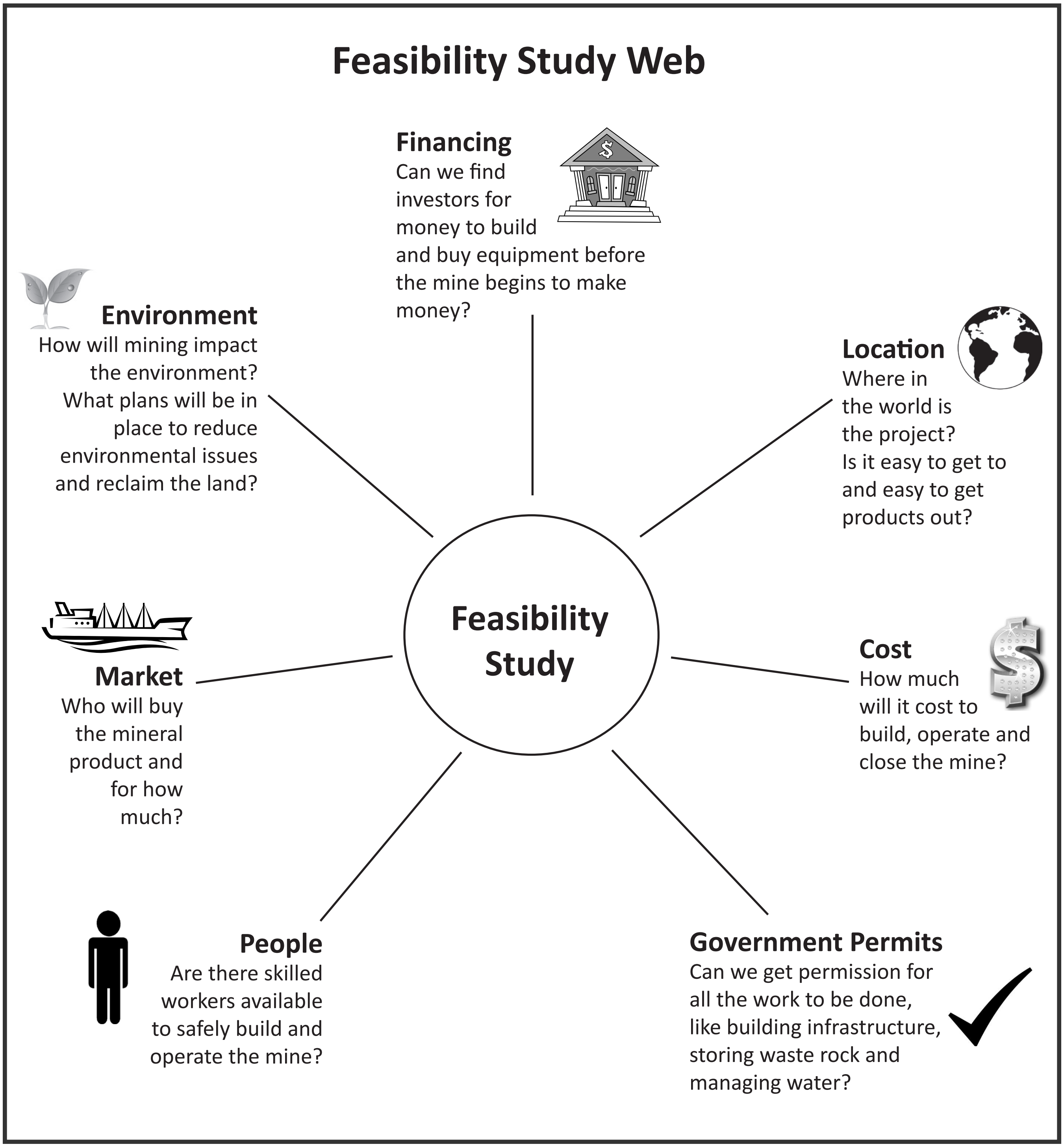
We are all mining engineers. We plan, design, and operate mines that get the mineral resources we use everyday, like copper for wiring, iron for steel, and aggregate for concrete.

PART 1 - Feasibility Study

Mining engineers are involved in all stages of mine development.



Riley and Jordan are geologists who have found a copper deposit. The company they work with has already hired environmental scientists to conduct their baseline environmental studies. They have now hired us to find out if the deposit will be profitable to mine.



Our first job is to complete a **feasibility study.** A feasibility study is very complex. Mining engineers look at all the costs and factors that determine if the mine will be profitable and if everyone involved will benefit. It will take several years to complete.

PART 1 - Feasibility Study

Julia and Tom calculate all of the costs of building and operating a mine.

Value of the Ore Body

Proven Reserves		500,000,000 tonnes
Average % Copper		0.3%
Ore Processed Annually		27,375,000 tonnes
Mine Life		18 years
Average Copper Recovery		85%
Calculated Copper Recovered		1,275,000 tonnes
Average Price for Copper		$3.00/lb ($6,600/tonne)
Total Value of Ore		**$8,415,000,000**

Construction Costs

Mine Development: Mining waste rock above pit		$50,000,000
Mine Buildings (office, warehouse, assay lab, etc.) and heavy equipment		$150,0000,000
Mill Building		$600,000,000
Power line		$100,000,000
Tailings Dam		$80,000,000
Total Construction Cost		**$980,000,000**

Operating and Maintenance Costs (18 years)

Mining		$1,500,000,000
Milling		$2,000,000,000
Payroll and Administration		$200,000,000
Transportation to Market		$600,000,000
Total Operations Costs		**$4,300,000,000**

Closure and Reclamation Costs

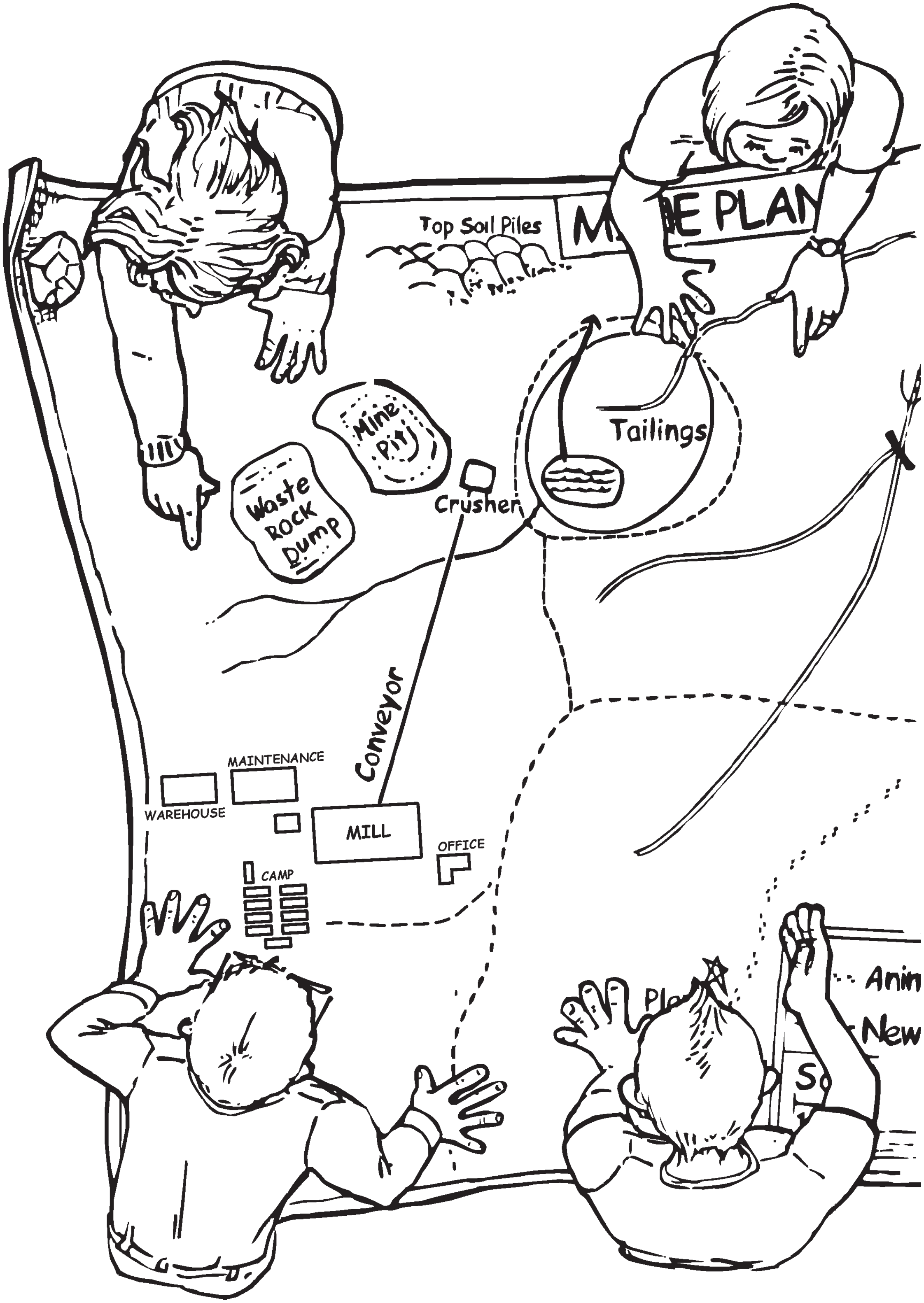
Removing buildings and roads, resloping waste rock dumps, seeding and planting entire site (roads, waste rock dumps, tailings dam, and pond margins), drilling and monitoring wells		**$40,000,000**
Total Costs		**$5,320,000,000**

You do the math.

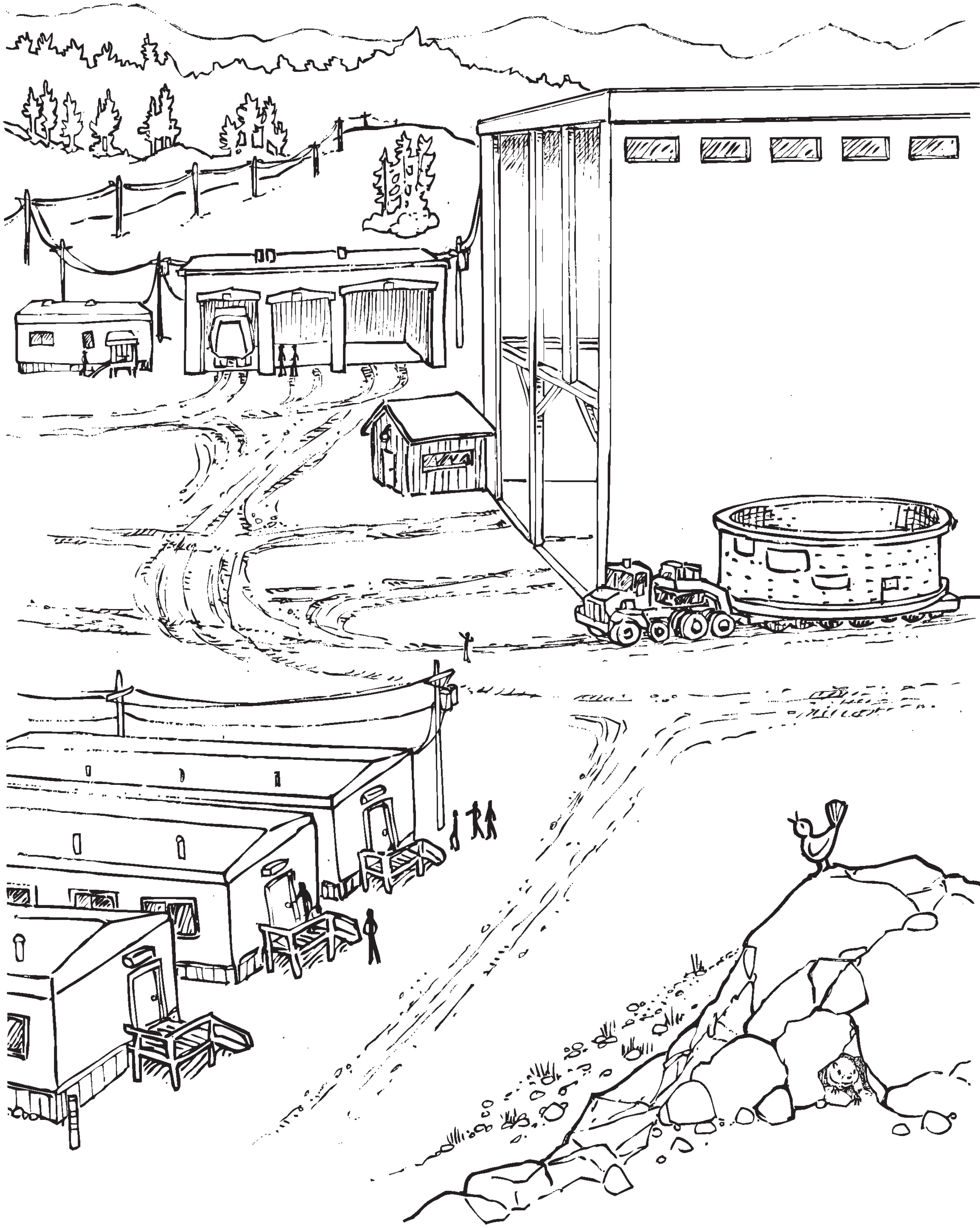
Is the mine feasible? Is it feasible if the value of copper is only $2.00/lb?

Answer key on page 24

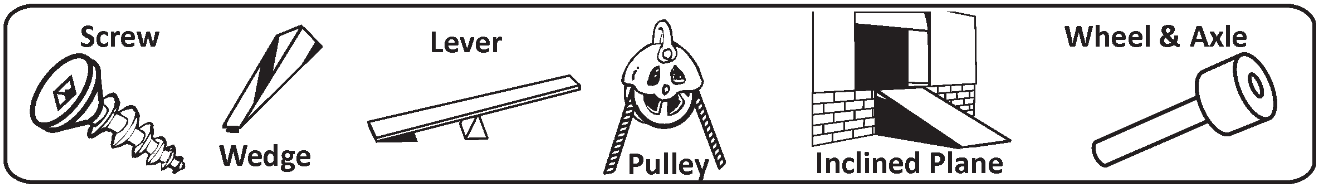
Building a mine takes 2-5 years.

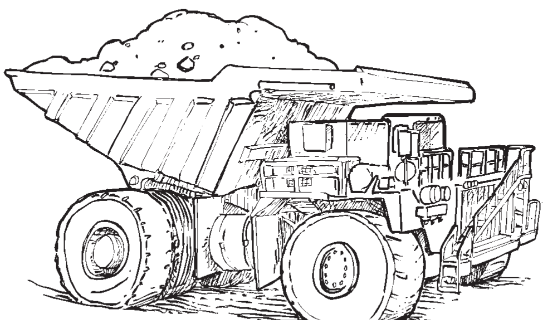


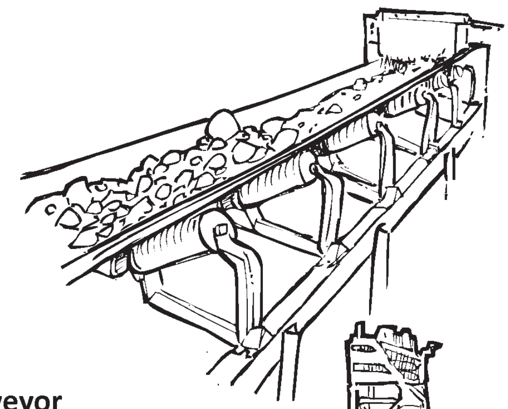
Mining engineers create the **design** and oversee the **construction** of the mine from the beginning. Julia gave our plans to a crew to begin construction.

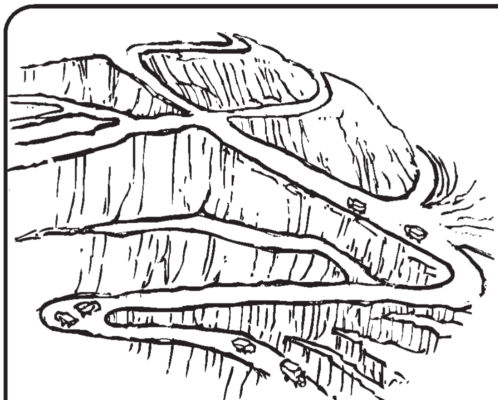


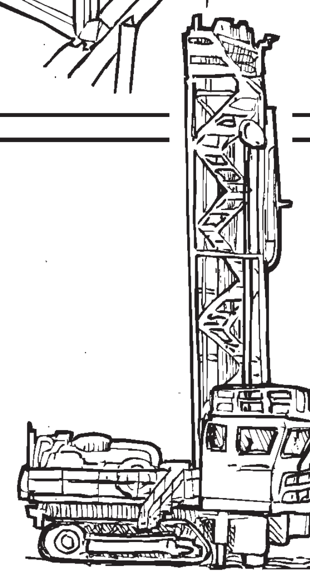
While the mine is being built almost all the workers live in **camp**. There are 800 workers here! The office and machine shop are finished. Pit construction is well underway and an important part for the mill arrived today!

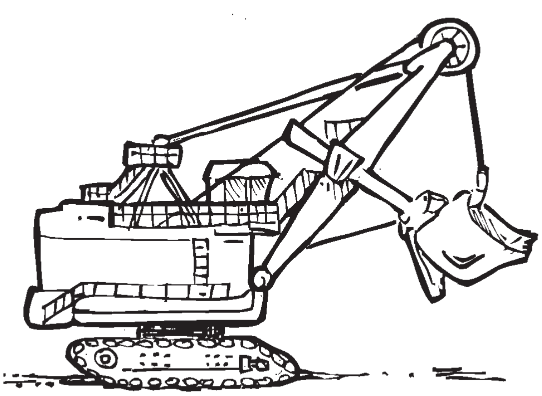


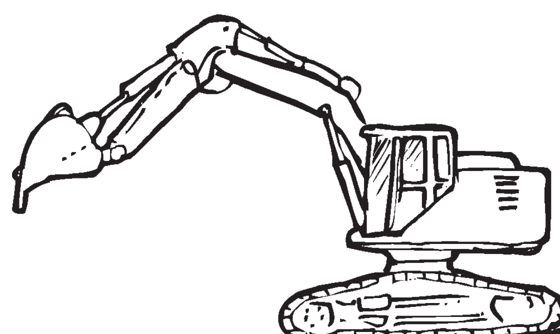

Haul Truck


Conveyor


Mine Road


Rotary Drill


Shovel


Excavator

Construction of the mine site requires hundreds of workers and many pieces of equipment including **simple** and **compound machines**.

Label the simple machine(s) that make up the mining machines and structures.

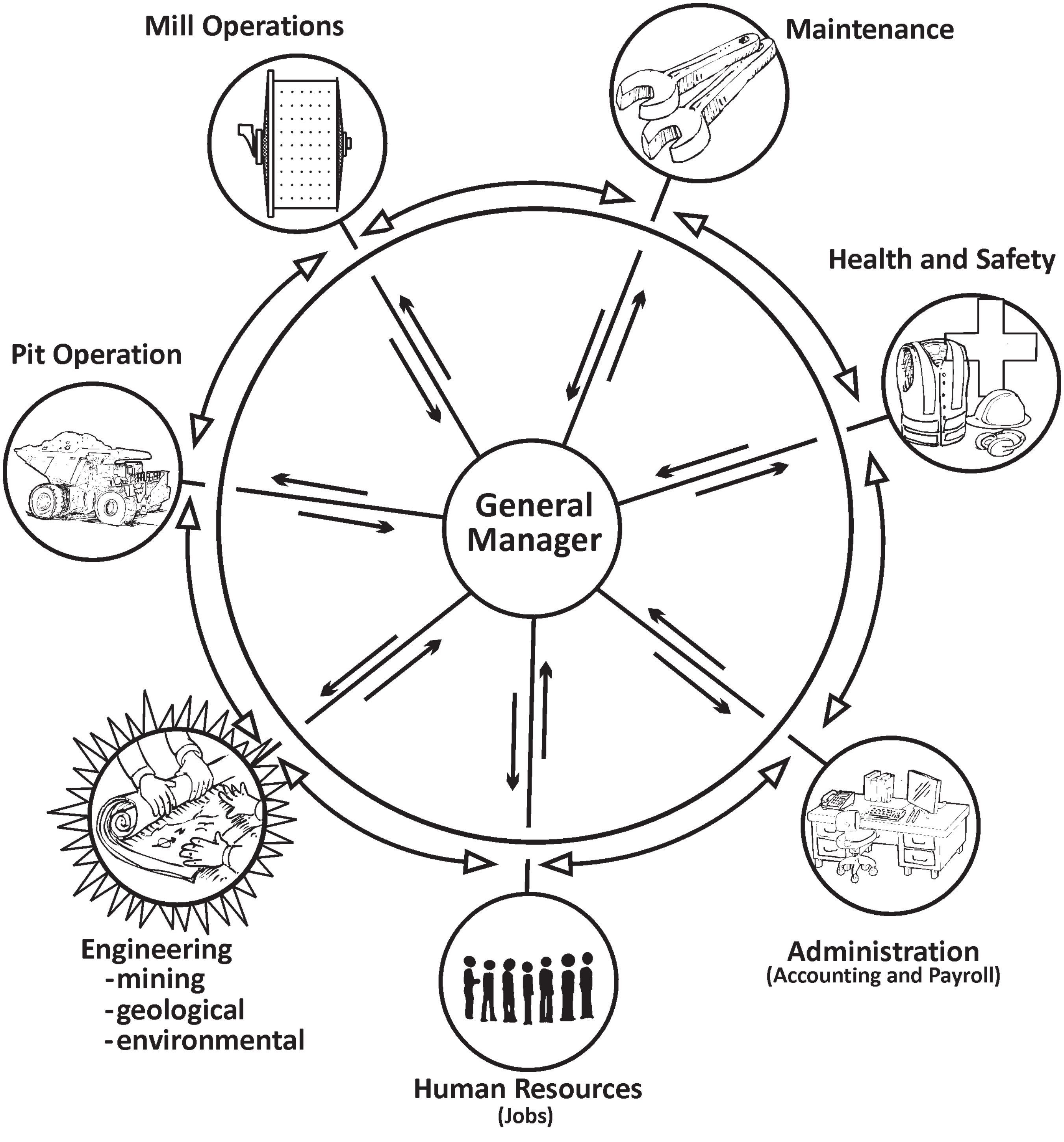
Answer key on page 24

PART 3 - Operations (Mining)

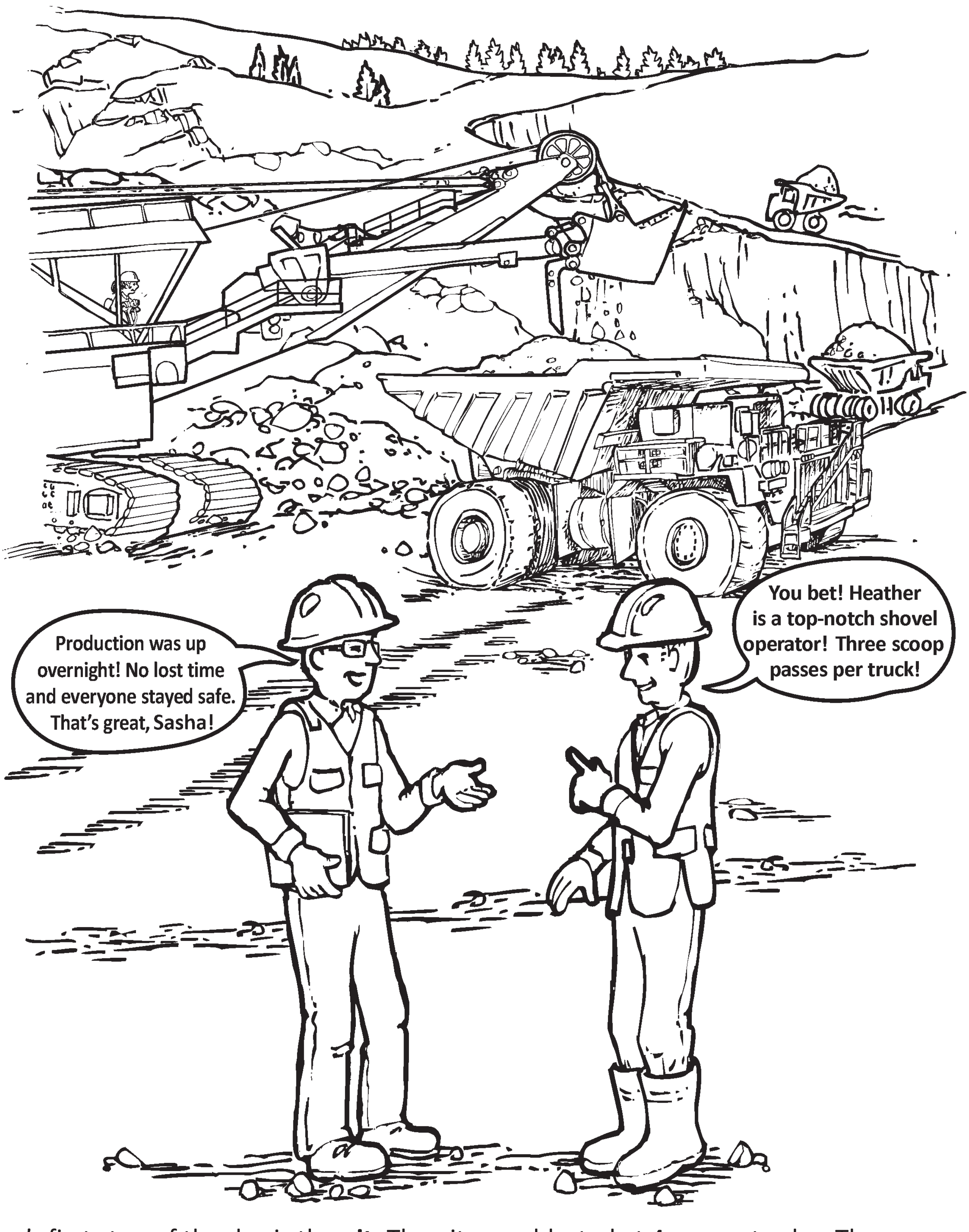
The mine is built and the processing plant, called the **mill**, is in operation. We are **mining**!

A mine operates 24 hours a day, 7 days a week, 365 days a year. At 6:00 am we are heading to work to start our shift. On the way we catch up with each other's news.

We are part of the **engineering team** at the mine. We collaborate with many other people.



Our job is to make sure the mine operates safely, smoothly, and efficiently. We aim to waste as little of everything as possible - fuel, time, electricity, and water. Our motto is "Reduce, Reuse, and Recycle".



Tom's first stop of the day is the **pit.** The pit crew blasted at 4 pm yesterday. The overnight report said that production was up; 85,000 tonnes of ore was mined and hauled to the **crusher** and 260,000 tonnes of waste rock was hauled to the **waste rock dump**.

Mining Math

There are 30 haul trucks working in the pit at all times. Each holds 250 tonnes.
Each truck has six tires. Each tire costs $50,000.
Ten of the trucks haul ore to the crusher. The others haul waste rock.
It takes 40 minutes to haul, dump, and return to the pit.

1) Haul truck drivers work an 8-hour shift and are not operating for 1 hour for lunch and breaks. How many round trips to the crusher can each truck make in one shift?

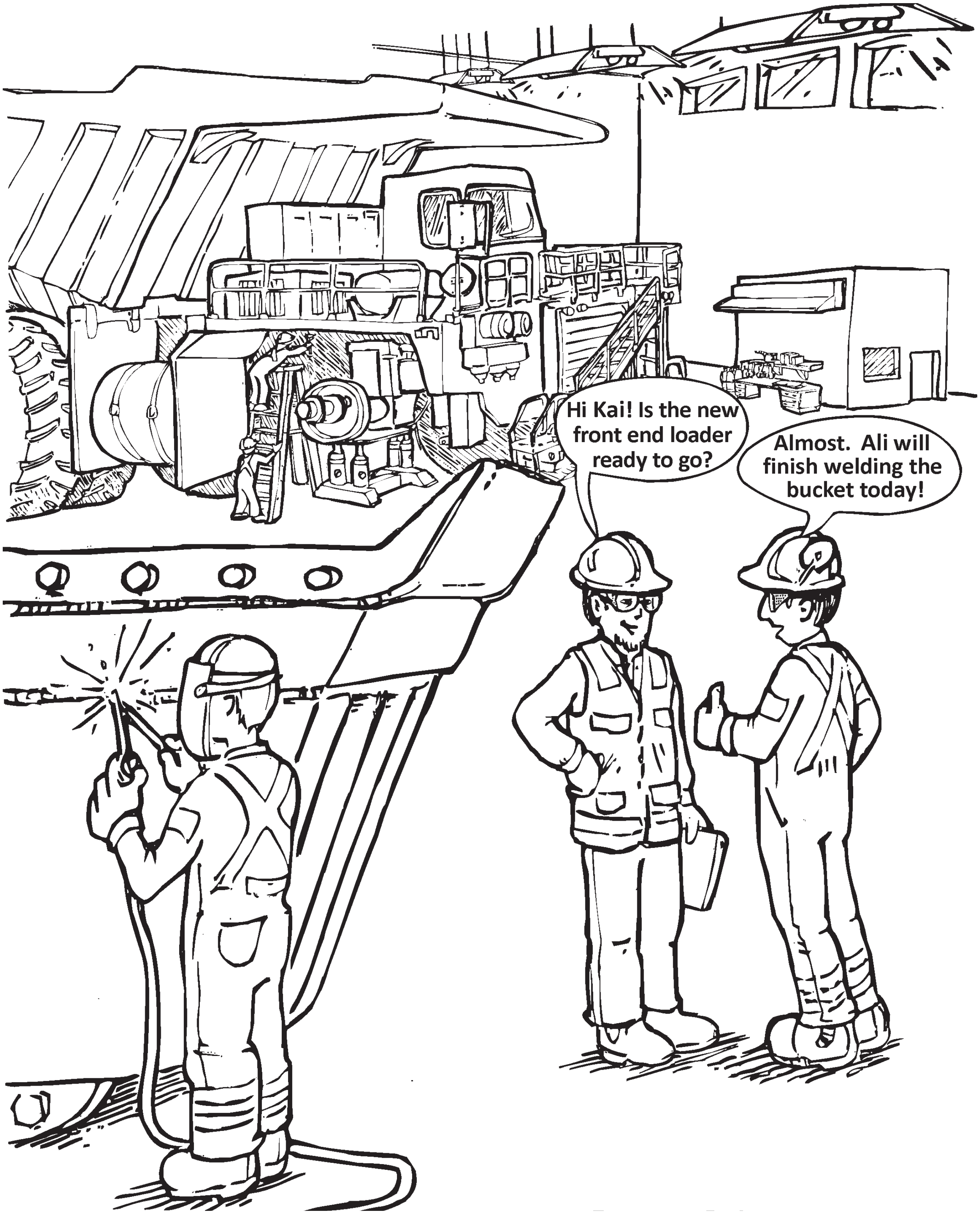
2) There are three 8-hour shifts in the pit. If there are no breakdowns, how much ore will be hauled from the pit to the crusher every day?

3) Under perfect conditions with no major break downs, how much ore will be taken to the crusher, then on to the mill each year?

4) In the mine design, the engineers calculated the ore reserves to be 500 million tonnes. Based on your calculation for Question 3, how many years will this mine operate before all of the ore is mined out?

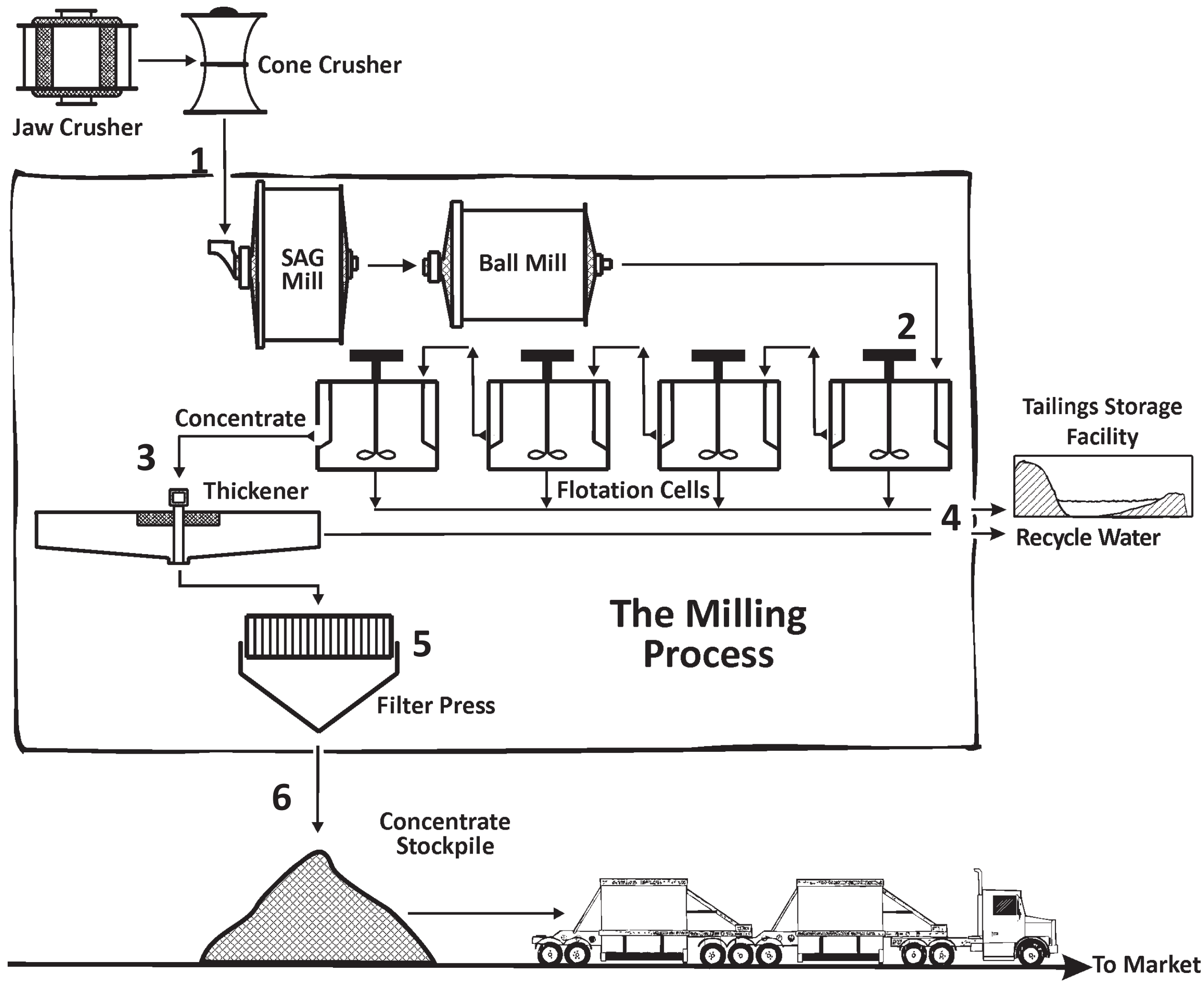
5) The haul truck tires wear out after about 6 months driving and must be replaced. How much does it cost to replace the tires for the entire fleet each year?

Answer key on page 24



A morning visit to the **shops** gives Rex an update on the equipment at the mine. When something breaks down or is out of service for routine maintenance, mine production slows down. We need all equipment in working order as soon as possible.

Ore mined in the pit is processed in a big building called the **mill**. This is where we get valuable minerals from the rock.



1) Chunks of ore are **conveyed** from the **crusher** into the mill. Here, the ore is mixed with water and large steel balls or rods in large rotating drums that grind the ore to sand.

2) Watery sand **(slurry)** flows into tanks **(flotation cells)** where chemicals are added to make the valuable ore minerals float and the waste sand sink. The floating ore minerals are called **concentrate**.

3) It is skimmed off and piped to a **thickener.**

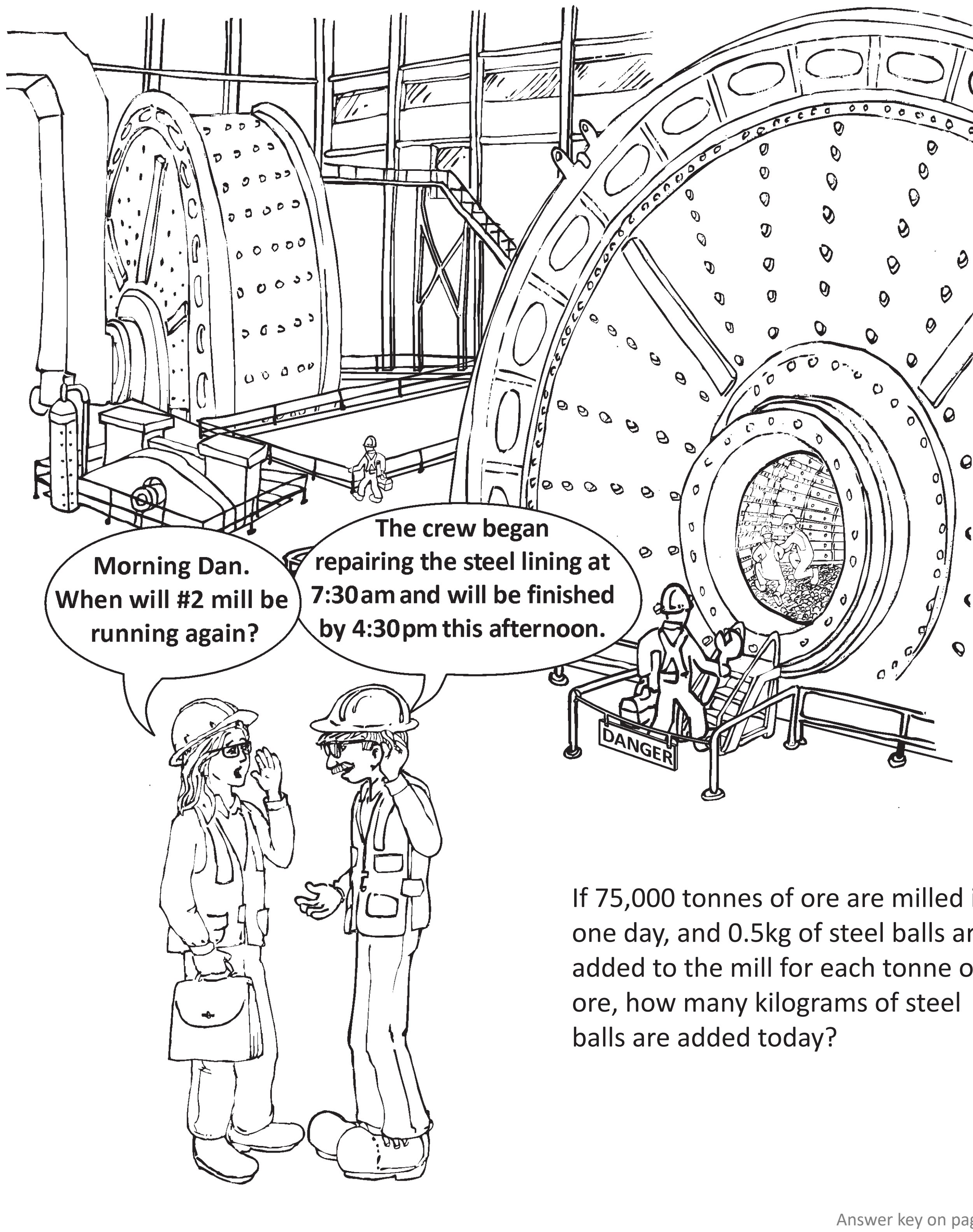
4) The waste sand, called **tailings**, are piped out of the building to a **tailings stoage facility**.

5) From the thickener the concentrate goes through a **press** to squeeze out the water. After a little drying the concentrate looks like shiny, black sand.

6) It is conveyed to a **stockpile** and is ready to be shipped to the buyer. The whole process is monitored on a computer by **mill control operators**.

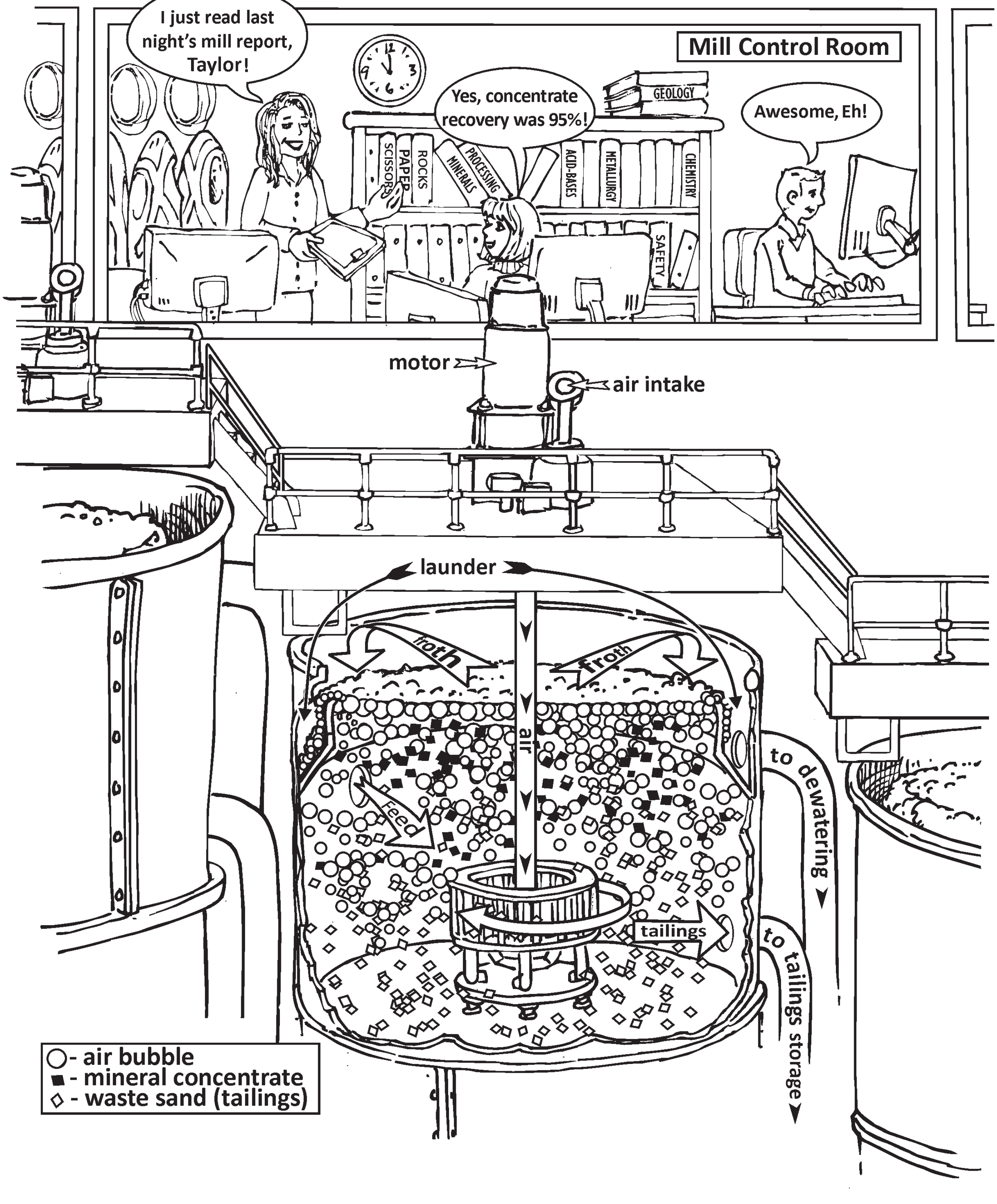
PART 3 - Operations (Mill)

Julia checks on mill operations several times a day to make sure everything is running smoothly. The large rotating drums are called **mills.** Steel balls are fed into some of these big machines, tumbling with the ore, like clothes in a dryer. Each ball is about the size of a softball and weighs 10 kilograms. The tumbling mass wears down the inside of the mill. Every so often the mill must be shut down so the steel plates inside can be replaced.



If 75,000 tonnes of ore are milled in one day, and 0.5kg of steel balls are added to the mill for each tonne of ore, how many kilograms of steel balls are added today?

Answer key on page 24

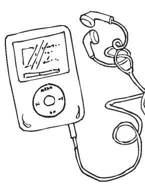
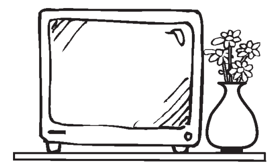


The **flotation cells** is where the magic begins. Valuable ore minerals stick to air bubbles using special chemicals called **collectors**. The mineral-coated bubbles float to the surface of the cell and flow over the side. The waste sand, called **tailings**, sinks to the bottom.

After flotation, water is removed from the concentrate. It is then conveyed to a **stockpile** in a shed at one end of the mill. This is the valuable product of our mine. We transport the valuable concentrate by truck to the buyer. The buyer will refine it and make a product we use in our everyday lives.

It Comes From A Mine Scramble

Unscramble the words below to reveal some of the products that are made from our copper concentrate!

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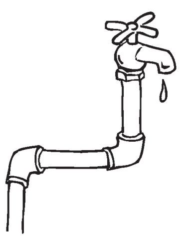
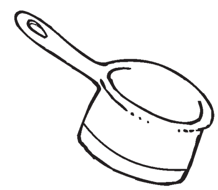
paptol _ _ _ _ _ _

ripeawtep _ _ _ _ _ _ _ _ _

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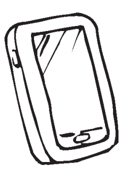
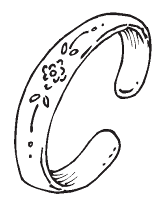

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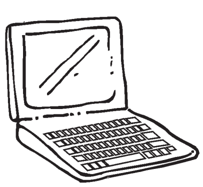
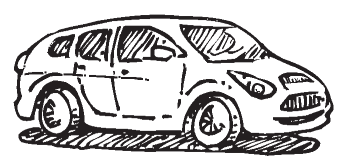
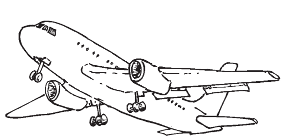
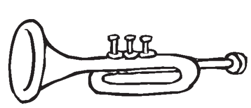
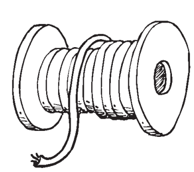



ivitleeons _ _ _ _ _ _ _ _ _ _

welejyr _ _ _ _ _ _ _

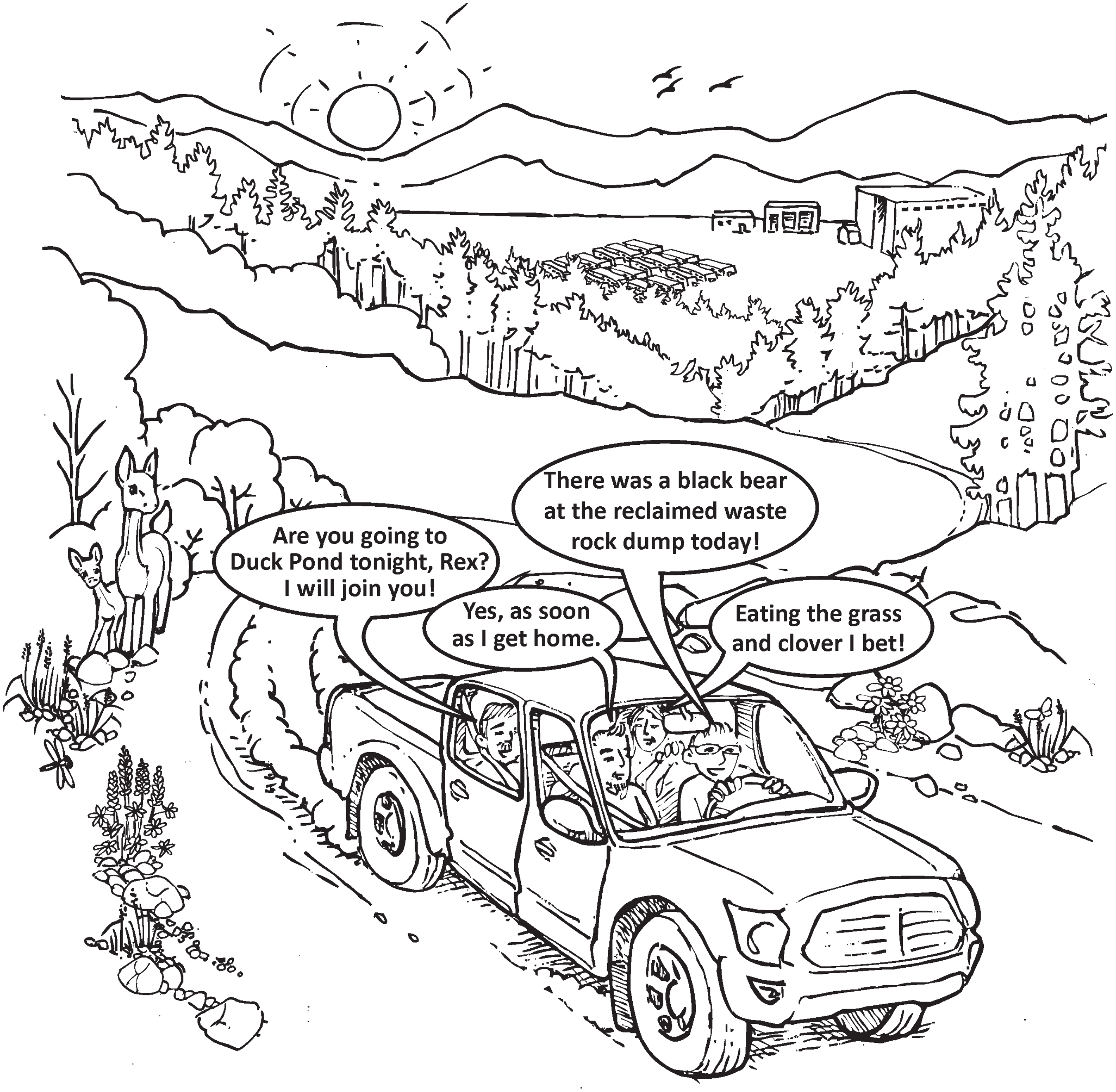
Answer key on page 24

PART 4 - Operations (Reclamation)

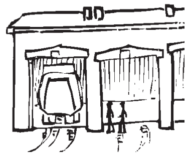
We work with the environmental team to make sure we store waste rock safely, keep the water clean, and protect wildlife habitat.

Our man-made **tailings storage facility** is in a valley with dams at both ends. When we increase the production of concentrate at the mill, we must also increase the height of the **dam** so as to make space for more tailings in the tailings storage facility.

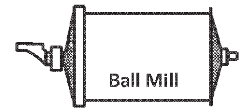
Waste rock from the pit has been hauled to the **waste rock dump** that our mining engineer team designed for the mine site. When the height, the width, and the depth of the dump site are at the maximum planned, then the dump must be **reclaimed**. The environmental team reduces the slope of the dump using dozers. They cover the slope with soil, and broadcast seeds and plant seedlings. They can do this even when the mine is operating.



Our shift is over, but the work goes on in the pit, the machine shops, and the mill. It's been a great day for team work! It's been a great day for problem solving! It's been a great day for planning for the future!



Mining Engineer Word Search



t	a	i	n	f	c	l	t	l	x	i	e	l	z	e
x	u	t	z	o	o	a	g	i	c	h	c	k	a	x
p	k	n	p	r	i	t	s	k	f	e	n	o	o	c
w	p	p	t	l	p	d	t	w	t	e	a	i	l	a
t	e	n	i	m	d	m	z	a	f	x	n	i	k	v
r	o	n	a	c	u	h	r	u	m	k	i	e	g	a
c	g	c	r	t	j	t	i	m	e	r	f	y	b	t
s	j	q	h	e	n	m	a	c	h	i	n	e	r	o
s	s	y	r	e	c	l	a	m	a	t	i	o	n	r
s	m	d	c	q	m	y	l	d	z	f	d	o	a	u
j	h	n	a	x	y	i	c	e	s	u	e	r	l	n
n	o	i	r	o	e	j	s	l	s	z	s	e	p	v
c	y	o	p	b	r	y	v	t	e	m	i	s	z	e
r	e	e	n	i	g	n	e	k	r	g	g	q	j	o
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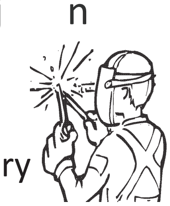

benefit	camp	chemistry
concentrate	control	copper
design	engineer	excavator
finance	machine	ore
plan	reclamation	recycle
reuse	roads	ship
tailings	time	mine

Answer key on page 24

Answer Key

Page 6 Feasibility Study Table

When copper is **$3.00/lb** ($6,600/tonne): Ore value **($8,415,000,000)** – (minus) Costs to build, operate and reclaim **($5,320,000,000) = $3,095,000,000** profit makes this mine feasible to develop. If copper is at **$2.00/lb** ($4,406/tonne) the ore value is only **($5,617,726,500)**. If the costs remain the same, then the profit margin over 18 years is **($5,617,726,500 - $5,320,000,000) = $297,726,500** which is too low a rate of return on the huge investment of money that would go into building, operating and reclaiming.

Page 9 Simple and Compound Machines

Haul truck (wheel and axel), Conveyor (wheel and axel), Mine road (inclined plane), Rotary drill (screw), Shovel (pulley and wedge), Excavator (wedge)

Page 13 Mining Math

1) 7 hours X 60 min/hour = 420 minutes; 420 minutes/40 minutes/trip = **10 round trips.**
2) 10 trips/truck/day X 250 tonnes/truck X 10 trucks = 25,000 tonnes/shift;
25,000 tonnes/shift X 3 shifts = **75,000 tonnes/day.**
3) 75,000 tonnes/day X 365 days/year = **27,375,000 tonnes/year.**
4) 500,000,000 tonnes ore reserves / 27,375,000 tonnes/year = **18 years.**
5) $50,000/tire X 6 tires/truck X 30 trucks X 2 changes/year = **$18,000,000 for haul truck tires each year.**

Page 16 Mill Supplies

75,000 tonnes ore/day X 0.5kg steel balls/tonne = **37,500 kg of steel balls added every day.**

Page 19 Mine Scramble

1) electrical wire
2) laptop
3) water pipe
4) cooking pot
5) smart phone
6) electric car
7) trumpet
8) iPad
9) airplane
10) television
11) jewelry

Page 23 Word Search

t	a	i	n	f	c	l	t	l	x	i	e	l	z	e
x	u	t	z	o	o	a	g	i	c	h	c	k	a	x
p	k	n	p	r	i	t	s	k	f	e	n	o	o	c
w	p	p	t	l	p	d	t	w	t	e	a	i	l	a
t	e	n	i	m	d	m	z	a	f	x	n	i	k	v
r	o	n	a	c	u	h	r	u	m	k	i	e	g	a
c	g	c	r	t	j	t	i	m	e	r	f	y	b	t
s	j	q	h	e	n	m	a	c	h	i	n	e	r	o
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s	m	d	c	q	m	y	l	d	z	f	d	o	a	u
j	h	n	a	x	y	i	c	e	s	u	e	r	l	n
n	o	i	r	o	e	j	s	l	s	z	s	e	p	v
c	y	o	p	b	r	y	v	t	e	m	i	s	z	e
r	e	e	n	i	g	n	e	k	r	g	g	q	j	o
a	z	w	t	r	o	o	p	j	y	y	n	f	j	n

MineralsEd

MineralsEd is an educational organization operating in British Columbia that is dedicated to encouraging and supporting Earth science, mineral resources, and mining education in school. It is a non-partisan, charitable organization.
www.MineralsEd.ca

Taseko

Headquartered in Vancouver, British Columbia (BC), Canada, Taseko Mines Limited (Taseko) is a dynamic North American mining company driven to unlock the true value of copper for its investors, employees, communities, and for a complex and changing world.
As a leading producer of the metals our society requires to transition to a low-carbon future, Taseko recognizes opportunity and delivers enduring value by developing and operating world-class copper mines and mineral properties in BC and Arizona. Taseko's reputation is built on operational efficiency, safety, and delivering 360 degrees of value.
Taseko is proud to support MineralsEd and its mission to inspire and encourage students to consider the vast array of career possibilities within the mining sector.

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