Building Tunnels

A Reading A–Z Level Q Leveled Book
Word Count: 802

Connections

Writing

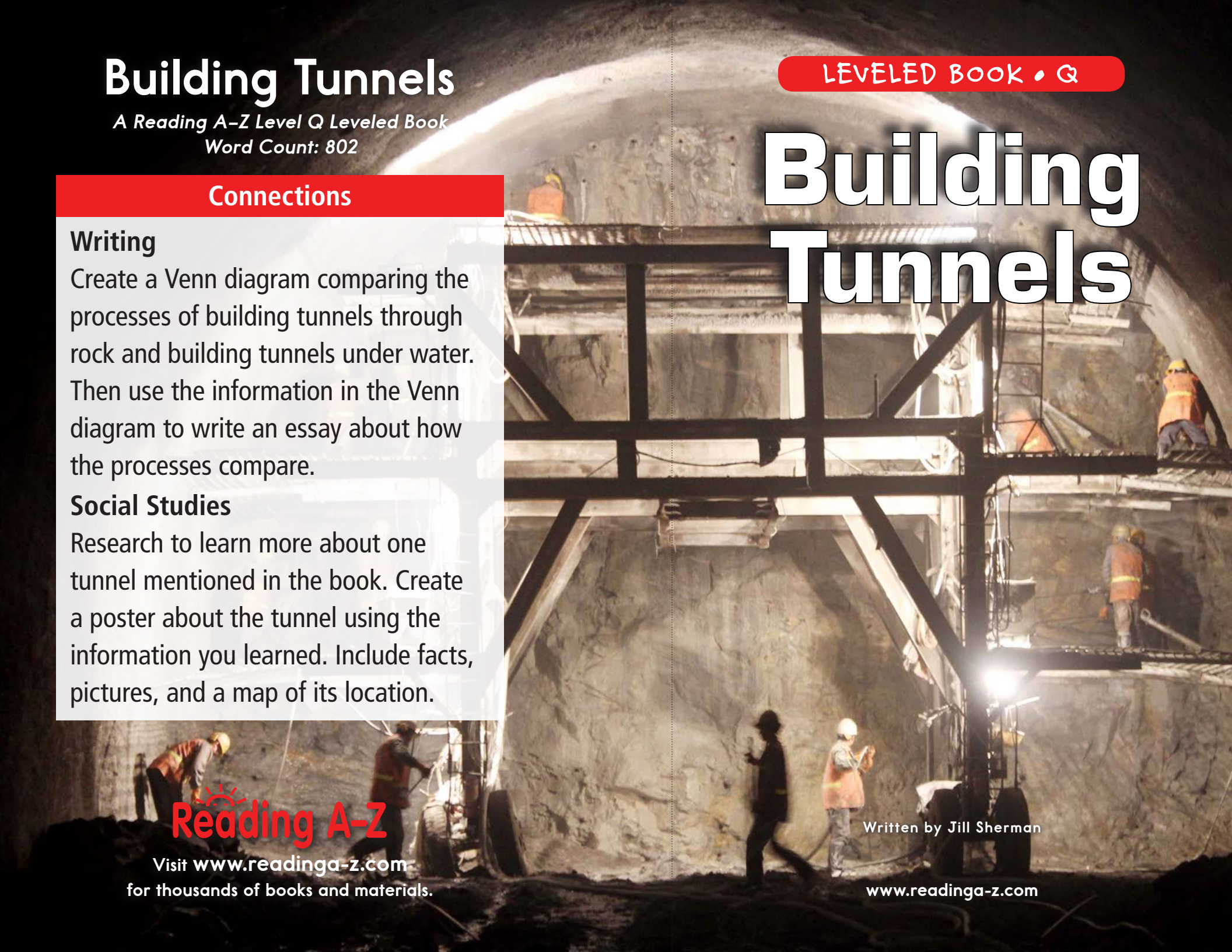
Create a Venn diagram comparing the processes of building tunnels through rock and building tunnels under water. Then use the information in the Venn diagram to write an essay about how the processes compare.

Social Studies

Research to learn more about one tunnel mentioned in the book. Create a poster about the tunnel using the information you learned. Include facts, pictures, and a map of its location.

LEVELED BOOK • Q

Building Tunnels



Written by Jill Sherman

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Focus Question

How and why are tunnels created?

Words to Know

boring	muck
collapse	obstacles
dynamite	sealed
engineers	stable
explosives	technology
line	trench

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Correlation

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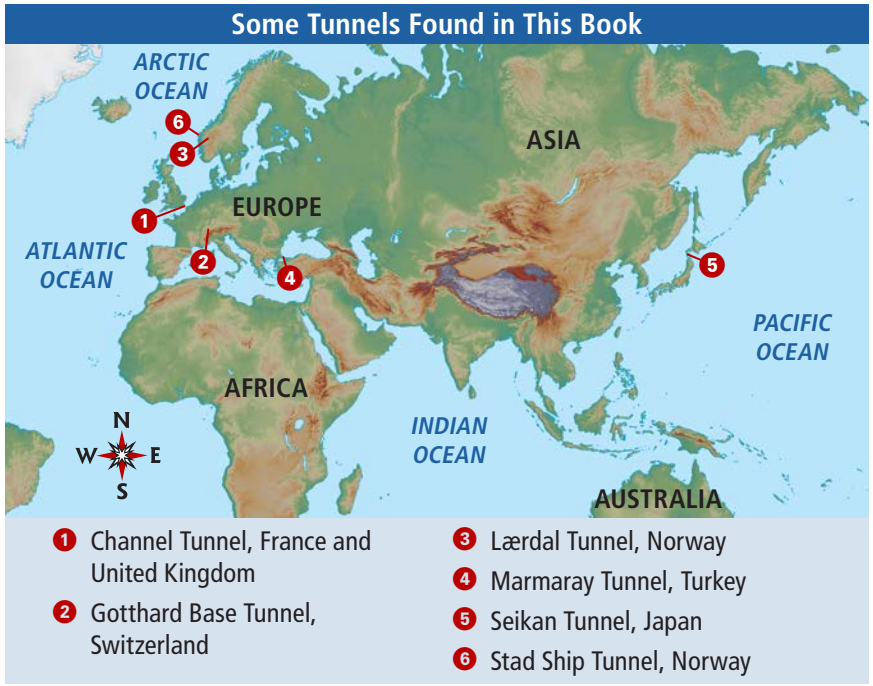
Fountas & Pinnell	N
Reading Recovery	30
DRA	30



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Hezekiah's Tunnel is an underground water tunnel in Jerusalem that likely dates from the eighth century BCE.

Going Places

For much of history, when travelers came across **obstacles** like mountains, they had a decision to make. Should they go around or over? Both options were difficult—until someone decided to go through!

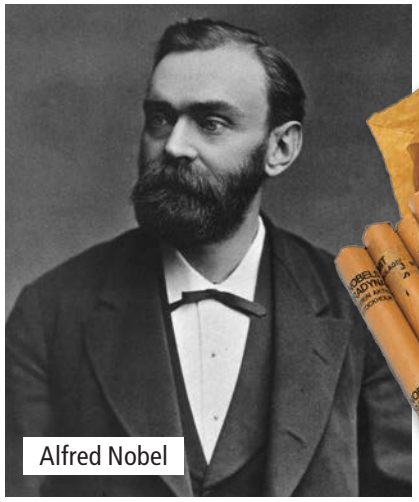
Today, tunnels allow safe and speedy passage through hills and mountains. They also allow people and goods to pass under cities, rivers, and seas. The largest tunnels are amazing examples of the work modern **engineers** can do.

The History of Tunnels

People have been building tunnels for thousands of years. However, for much of that time, tunneling was dangerous and could take many years of hard work.

In the 1860s, tunnel building became much easier when Alfred Nobel created **dynamite**. Easy to use and safer than other **explosives** at the time, dynamite allowed people to blast through rock in moments.

Since then, **technology** has continued to advance, and tunnels have grown larger and more amazing.



Alfred Nobel

dynamite

Alfred Nobel became rich from his inventions, including dynamite. When he died, his money was used to create the Nobel Peace Prize.

In 2016, almost 2 billion people rode New York City's subways. If laid end to end, these tunnels would stretch from New York City to Chicago, Illinois!

Building Tunnels

Today, workers have carved tunnels through rock mountains, under large bodies of water, and below busy cities.

Before building a tunnel, engineers look at soil and rock samples. They drill test holes to discover the type of rock they will need to dig through. Once they have this information, they can design a tunnel that will not **collapse**.

Tunneling usually follows three basic steps: dig, support, and **line**. First, workers dig part of the tunnel. They may use tools, machines, or explosives. Once part of the tunnel has been cleared, it is time to start step two: support. Any unstable ground must be made stronger to prevent a collapse. How they do this depends on the material the tunnel has to go through. Once the tunnel has been made **stable**, workers build the lining, or inside, of the tunnel. Using these three basic steps, people have built amazing tunnels all over the world.

More than nine hundred road tunnels have been built through mountains and under water in Norway.

Math Minute

The Lærdal (LAR-dahl) Tunnel, at about 25 kilometers (16 mi.), is the longest road tunnel in the world! It cuts through mountains in Norway. If you travel from Borgund (BOR-gund) to Flåm (FLAWM) without the tunnel, you will have to drive 84 kilometers (52 mi.). Using the tunnel, the route is only 56 kilometers (35 mi.). How much distance will you save by using the tunnel?

Answer: 28 km (17 mi.)

Workers used more than 2,540 metric tonnes (2,800 tn.) of explosives to build the Seikan Tunnel.

Tunnels Through Rock

The Seikan Tunnel connects Honshu, the main island of Japan, with Hokkaido. It's 54 kilometers (34 mi.) long, making it the second-longest tunnel in the world. To build the tunnel, workers had to blast through tons of hard rock.

Do You Know?

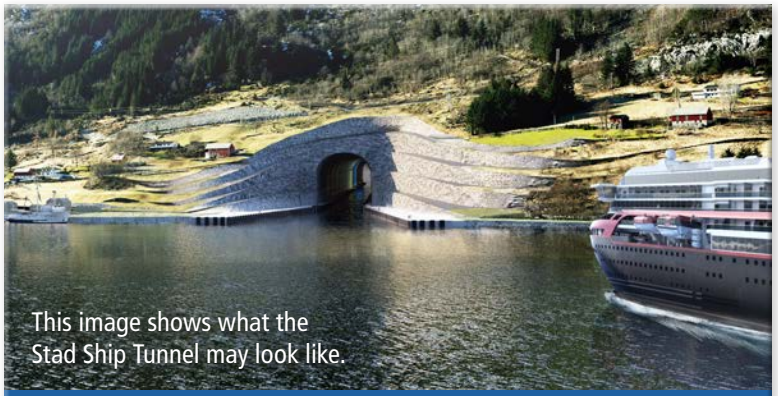
In 2016, the world's longest and deepest railway tunnel opened in Switzerland. The Gotthard Base Tunnel travels beneath the Swiss Alps for an incredible length—57 kilometers (35 mi.)!

Workers set explosives in May 2014 to create the Brenner Base Tunnel, a train tunnel in Austria.

To blast through rock, workers first drill small holes. The type of rock determines how deep and how far apart the holes need to be. Then, workers pack the holes tightly with explosives. After they set off the explosives, workers cart away the pieces of rock created by the blast—called **muck**.

A worker cuts a rock bolt that had secured a weak section of rock from the roof of a train tunnel in New York City, in 2008.

Tunnels of solid rock often don't need extra support because they are already sturdy. However, areas with broken rock still need to be secured. Workers may install long bolts or spray the area with concrete. They need to make sure that the rocks won't move as they continue to work on the tunnel.



This image shows what the Stad Ship Tunnel may look like.

Wowser!

Norway plans to build the world's first ship tunnel. It will be almost 2 kilometers (1 mi.) long.

Tunnel-boring machines are also called *moles*.

For some tunnels through rock, workers use huge tunnel-**boring** machines. At the front of the machine is a plate in the shape of a circle that contains disk cutters. The plate rotates, carving and grinding into the rock. The muck is scooped onto a belt that moves back toward the tunnel entrance. While these machines make building tunnels easier and faster, they cost millions of dollars. If they break down, they can sometimes take months or even years to repair.

Workers set a tail shield section of a tunnel-boring machine into position for a new underground light rail train in Los Angeles, California, in 2016.

Tunnels Through Soft Earth

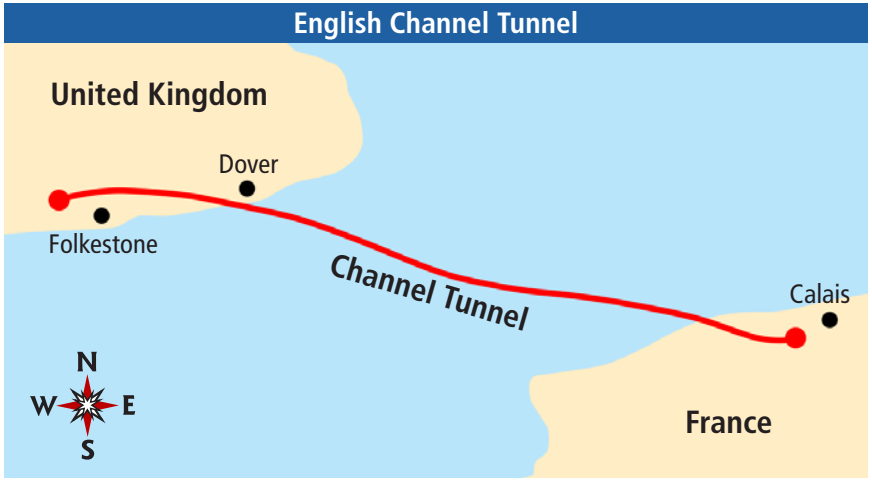
Building tunnels through soft ground, such as sand or gravel, can be dangerous. The earth can easily collapse. To stop this from happening, workers push a steel cylinder called a *shield* into the earth for support. They then dig out the material within the shield. Next, they install a liner, which is often made of steel or concrete. With that complete, they push the shield deeper ahead and repeat the process. Marc Brunel invented the method in order to build the Thames Tunnel in the 1840s.

Tunnels Under Water

Building tunnels under bodies of water presents additional challenges. In many instances, workers make a **trench** while building sections of the tunnel aboveground. When the trench is complete, the sections of tunnel are sunk and connected together. When everything is **sealed**, the water is pumped out of the tunnel.

The Marmaray Tunnel, which connects the European and Asian sides of Istanbul, Turkey, was built using the trench method.

Workers used huge barges to carry sections of the Marmaray Tunnel into the sea and sink them into place.



The Channel Tunnel, which crosses under the English Channel between England and France, was built using another method. Eleven tunnel-boring machines began work on either side of the tunnel. They met in the middle two years later, and the tunnel was finally opened four years later, in 1994.

Approximately four hundred trains pass through the Channel Tunnel each day. The trains carry passengers, cars, and freight.

Tourists experience strange images as they ride self-driving cars through the Bund Sightseeing Tunnel in Shanghai, China.

Conclusion

These amazing tunnels help millions of people and tons of goods move each day all around the globe.

As people continue to create newer, faster, and better modes of transportation, they still come across the same obstacles. To get people where they're going faster, new tunnels will need to be built.

Fortunately, technology allows for the construction of longer, deeper, and wider structures more easily and safely than ever before. Who knows what amazing tunnel will be built next?

Glossary

boring *(adj.)* able to make a hole with a spinning tool or a twisting motion (p. 11)

collapse *(v.)* to fall apart or fall down (p. 6)

dynamite *(n.)* an explosive material used for blasting (p. 5)

engineers *(n.)* people who design, build, or repair machines, buildings, bridges, or other structures (p. 4)

explosives *(n.)* substances that can blow up with a sudden release of energy (p. 5)

line *(v.)* to cover the inside of something (p. 7)

muck *(n.)* broken material in a mine that is created by an explosive blast and must be removed (p. 9)

obstacles *(n.)* things that get in the way, preventing progress or movement (p. 4)

sealed *(v.)* closed tightly to stop anything from passing through or leaking (p. 13)

stable *(adj.)* balanced or steady; reliable and unlikely to change (p. 7)

technology *(n.)* the use of scientific knowledge or tools to make or do something (p. 5)

trench *(n.)* a long ditch (p. 13)