Family edition

Tunnel Boring Lab: The Street Above, Face Pressure and Settlement

Ages 11-14 · about 45 minutes, in one sitting

In Tunnel Boring Lab your child programs a tunnel boring machine under a city street. In this level it passes under shops and an apartment building, and the street must not sink more than 10 mm.

What you need

- A computer or Chromebook with a current browser.
- The link: mytekdev.com/try/tunnelboringlab?lesson=the-street-above-face-pressure-and-settlement&ref=fam-tunnelboringlab-3. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/tunnelboringlab?lesson=the-street-above-face-pressure-and-settlement&ref=fam-tunnelboringlab-3. A short guide opens over Level 8, The buildings above. The street is drawn cut open along the tunnel's line like a diagram: the buildings and the road on top, then topsoil, sand, clay and granite. The machine is under the street, boring from the launch shaft on the left. The box at the top says what the level wants and what is happening; the guidance screen is the round dial. Here the survey points are the small marks on the fronts of the shops and the apartment building, and their readings are in mm.

1. **The program.** Blocks opens with it written: set target to 1.6; push 50 all round; turn at 3; then 25 times, start a stroke without waiting, and while it is still boring, turn the screw at 50 + 100 x (face pressure - target) and wait 10 seconds; then build a ring. Over the target, the screw runs faster and lets pressure out; under it, slower.
2. **The street.** Every ring takes a little more ground than the tunnel's own size, and the street above sinks into a shallow trough, deepest over the tunnel. The less the face pressure falls short, the less ground each ring takes.
3. **Speed.** A drive is many hours of the machine's own time. Speed up, twice, runs it at 6 times faster, 22 minutes of the drive a second, so most runs take under a minute. Play always puts the machine back in the shaft and runs the program as it is now.
4. **Numbers to expect.** Target 1.6: a point on the shops sinks 10.1 mm after ring 11, and work stops. 1.9: passes, the worst point down 8.5 mm. 2.2: 5.8 mm. 2.4: 4.1 mm. 2.6: 2.3 mm. 2.7 or 2.8: the drive stops before the first ring, the pressure above the ground's weight of 2.5 bar, and the street pushed up.

> The level's own target, from the depth and the water table, is about 1.9 bar here (the Level 7 formula). Higher targets take less ground in this model. The model's upper limit is the weight of the ground above, about 2.5 bar at 14 m, plus a little; real projects set it from the ground survey, with a margin.

The ideas, in plain words

A soft-ground tunnel boring machine holds up the face by keeping the dug soil under pressure in a chamber behind the cutterhead. A screw conveyor takes the soil out at the bottom: turn it faster and the pressure falls, slower and it rises. This kind of machine is called an earth pressure balance machine, because the chamber pressure balances the ground and water pushing in.

However well it is run, a tunnel takes a little more ground than its own size, called volume loss, a fraction of a percent on a well-run drive. The ground above sinks into a trough shaped like a bell curve, deepest over the tunnel. Engineers predict it before the drive and measure it during it at survey points on buildings, with trigger levels at which work slows or stops. Real projects set two or more trigger levels; the app uses the last one, where work stops.

Too much pressure is also a hazard: past the weight of the ground above, the chamber pushes the ground up, and can blow out at the surface. The safe choice is a window, not a maximum. Nothing in the app caves in on anyone: buildings settle by millimeters, shown as numbers, and never fall.

Do it together

1. Open mytekdev.com/try/tunnelboringlab?lesson=the-street-above-face-pressure-and-settlement&ref=fam-tunnelboringlab-3 together and press play, then `Speed up` twice. Watch the survey points on the shops.

   > **You'll know it worked when:** After ring 11 a point on the shops sinks 10.1 mm, past its 10 mm trigger, and work stops.

2. Open `Blocks`, set target to 1.9 in the first block, go back to `Simulator` and press play.

   > **You'll know it worked when:** Green: 25 rings, the worst point down 8.5 mm.

3. Try 2.2, 2.4 and 2.6.

   > **You'll know it worked when:** The street sinks less each time: 5.8, 4.1 and 2.3 mm.

4. Now try 2.8.

   > **You'll know it worked when:** The drive stops at once: the pressure passed the weight of the ground above, and the street was pushed up.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Why does the street sink at all when the tunnel is lined as it goes?

- What does the program do when the pressure is over the target?
- Which building sank first at 1.6, and after which ring?
- Why did 2.8 stop the drive?
- Which target would you choose, and how much room does it leave on each side?

> The last question is the one that matters. A child who names the margin on both sides, sinking and pushing up, has the trade-off. A child who picks 2.6 because it sank least has read the data but not the risk.

For younger and older kids

Younger: For a younger child, stop after 1.9 and talk about why the hole a machine digs makes the ground above it move.

Older: For an older child, ask which target a real engineer would choose, and why not the one that sank least.

Keep going

- Open Level 12: grout the gap behind the rings. How much does the worst point change at the same target?
- Read Help, How it works: what is the formula for the target, and why does it add the water's pressure?
- Open the Python tab and find the loop. What does the 100 do? Try 50 and 200 at target 2.2.

Bring it into other subjects

- Math: plot the worst survey point against the target. Where would you draw the line for 10 mm and for the push-up?
- Earth science: why does sand below the water table run more easily than clay? Try Level 9.
- Careers: look up what a geotechnical engineer or a surveyor does on a tunnel project.
- Civics: a city tunnel passes under homes. Who should be told before it starts, and what should they be told?

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Tunnel Boring Lab: The Street Above, Face Pressure and Settlement
SUBJECTS	Engineering, Earth science
TIME	45 minutes
WHAT WE DID	Set the face pressure of a simulated tunnel boring machine under buildings, read settlement at survey points, and explained the trade-off between sinking and pushing up the street.
SKILLS PRACTICED	Reading measurements; Testing a range; Trade-offs and safety margin

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/tunnelboringlab?lesson=the-street-above-face-pressure-and-settlement

Essential question: How hard should a tunnel machine press on the ground in front of it?

Warm-up: What could go wrong above a tunnel under a street? _____

1. **Vocabulary.** Face, face pressure, bar, settlement, survey point, trigger level: write each in your own words.

2. **The starter.** Target 1.6: ____ sank ____ mm after ring ____ . The trigger is ____ mm.
3. **My table.** Target / worst survey point (mm) or what stopped it. 1.9: ____. 2.2: ____. 2.4: ____. 2.6: ____. 2.8: ____.

4. **The window.** The street stays inside its triggers from a target of about ____ to about ____ .

1. Which target would you choose for a real street, and why?

2. Why is more pressure not always safer?

Quick check

Name: _____

1. Raising the face pressure (but not too far) makes the street: (A) sink more (B) sink less (C) no different

2. A trigger level is: (A) the settlement at which work stops (B) the deepest the tunnel can go (C) the pressure in the chamber

3. A friend sets the target to 3.0 so the street cannot sink at all. Use what you learned today to say what will happen, and what to do instead.

Answers

QUESTION	ANSWER	WHY
1	B	The face is held closer to the ground's own push, so each ring takes less ground.
2	A	Survey points are watched against it; here 10 mm down or 5 mm up.
3	Open answer	Past the weight of the ground above, about 2.5 bar here, the street is pushed up and the drive stops. Choose a target in the window, such as 2.2, with room on both sides.

If your state or umbrella school asks, this lesson covers NGSS MS-ETS1-2, NGSS MS-ETS1-4.

Terms of use

This lesson was made by mytekDev. You may print and copy it for the children you teach at home, and change it for them. You may not sell it, share it with other families, or post it publicly.

The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

© 2026 mytekDev. All rights reserved.