Learn more at Milepost 31

Bertha spent most of her time out of sight, but you don’t have to be underground to see her. A 10-foot-long, motorized model of the machine is on display at Milepost 31, the public information center in Seattle’s Pioneer Square neighborhood.

In addition to interactive displays and other cool exhibits that tell the story behind the efforts to replace the viaduct, Milepost 31 highlights the people and projects that shaped Pioneer Square. You’ll find history, artifacts and interactive exhibits designed to broaden your understanding of the land beneath you. You’ll explore the neighborhood’s changing landscape, from earth-moving efforts of the past to the massive tunnel project that will soon move SR 99 underground and reconnect Pioneer Square to the waterfront.

What’s in a name?

Like most ships, tunneling machines are typically named after females. Our machine is named Bertha, in honor of Bertha Knight Landes, who was elected mayor of Seattle in 1926 and was the first woman to lead a major American city. A panel of judges that included former Gov. Chris Gregoire and former Transportation Secretary Paula Hammod selected Bertha from more than 150 submissions to a naming contest among Washington state students.

Fun facts

• The 57.5-foot-diameter, 367-foot-long machine is the size of some of Washington State Ferries’ largest vessels. It weighs nearly 8,000 tons.
• The cutterhead is pushed forward by 56 propulsion jacks with a combined thrust of 44,000 tons (a Boeing 747’s engines produce approximately 120 tons of force)
• The cutterhead is powered by 22 motors generating 16,500 horsepower.
• Over the course of tunneling, crews removed 850,000 cubic yards of soil. If you were to pile all of it on the football field at nearby CenturyLink Field, you’d end up with a rectangular pile of dirt more than 400 feet tall. That’s 100 feet taller than the stadium’s roof.

Visit the website at www.AlaskanWayViaduct.org
Call the hotline at 1-888-AWV-LINE
Follow on Twitter: @BerthaDigsSR99
Send an email to viaduct@wsdot.wa.gov

For more information

Tunneling toward a new SR 99 corridor

The art and science of tunneling has come a long way since the days of pickaxes and whale-oil lamps. Today crews use machines that bore through the earth, building a tunnel behind them as they go. Underneath downtown Seattle, a record-breaking tunneling machine nicknamed Bertha dug the tunnel that will replace the SR 99 Alaskan Way Viaduct.

The Washington State Department of Transportation is replacing the viaduct because the 1950’s-era concrete structure is aging and vulnerable to earthquakes. Tunneling allows the viaduct to remain open for most of the construction progress, minimizing traffic disruption. The key to this approach is Bertha.

Named for Seattle’s first female mayor, Bertha Knight Landes, the machine is 57.5 feet in diameter and 367 feet long. At the time she was built, Bertha was the largest-diameter tunneling machine in the world. Her 1.7-mile path takes her from an 80-foot-deep launch pit situated to the west of Seattle’s stadiums, underneath downtown, to the disassembly pit near the Space Needle.

Americans with Disabilities Act & Title VI Information

Americans with Disabilities Act (ADA) Information: This material can be made available in an alternate format by emailing the WSDOT Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

Title VI is the Washington State Department of Transportation’s (WSDOT) policy to assure that no person shall, on the grounds of race, color, national origin or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT’s Office of Equal Opportunity (OEO). For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, please contact OEO’s Title VI Coordinator at (360) 705-7082.
A cross between a shovel and a submarine

How does a tunneling machine work? The answer, as you might expect, is complicated. Bertha was custom-built for the specific job of tunneling beneath downtown Seattle. Her different functions can be broken down into several parts:

1. **Cutterhead**: The machine's front end is known as the cutterhead for good reason – it has more than 700 cutting tools that chip, grind and cut away the ground in front as it rotates.

2. **Tunnel shield**: Situated directly behind the cutterhead, this cylindrical steel tube protects crews and equipment from the surrounding ground.

3. **Segment erector**: Behind the cutterhead and protected by the shield, two mechanical arms lift and place curved concrete segments into rings to create the tunnel's exterior wall. Bertha then uses propulsion jacks to push off the newest-built ring, tunneling forward and creating space for the next ring.

4. **Conveyor belt**: A massive conveyor belt moves excavated soil from the front of the machine out of the tunnel to barges waiting at nearby Terminal 46. The belt will eventually reach nearly two miles in length as crews extend it as Bertha progresses. Clean tunnel spoil (the dirt) is barged to a disposal site on the west side of Puget Sound.

5. **Trailing gear**: More than 300 feet of support gear trails behind the machine. It includes everything the machine and its crew needs, from supplies like grout and grease to mechanical repair and maintenance equipment.

Fitting a square road into a round tube

Behind Bertha, crews work in the completed tunnel to build the future highway. The completed tunnel will have two lanes in each direction, stacked on top of each other with space on the sides for emergency exits and other safety, maintenance and operations systems.

To build a rectangular box in a round tunnel, crews first build corbels, which are concrete ledges that give the round tunnel a flat foundation to support the walls and lower deck. Crews then use formwork built atop the corbels to pour the concrete for the road deck walls. Once the walls are poured and sufficiently cured, crews build the top deck. The lower deck will be built after tunneling is complete. All of this concrete is reinforced with steel rebar that adds strength and protects against expansion and contraction.

This work takes place in sections – the corbels are built in 54-foot sections each requiring four tons of rebar and 108 cubic feet of concrete – so the road deck grows as the tunnel grows ahead of it.

Driving when you don’t have mirrors

A machine as complex as Bertha requires a lot of specialized expertise, and many different sets of eyes, to operate. More than 100 crew members worked on Bertha over the course of a given day, doing everything from machine maintenance to steering.

Monitoring the ground during the tunnel drive is critical to protecting people, buildings and infrastructure above the tunnel route. Real-time monitoring happens from both inside the tunneling machine and on the surface along the tunnel route. Crews inside the machine measure the type and volume of soil excavated to confirm they are tunneling at the correct rate. There are eight different types of soil along the tunnel route, and each has its own characteristics. Sand, for example, is harder to control than clay.

On the surface, an extensive system of precise and accurate monitoring tools keep an unblinking watch on the buildings and ground along the tunnel route. Instruments installed on the ground and on buildings along the tunnel route watch approximately 4,000 monitoring points. Should ground movement occur, crews can inject grout from the surface or from Bertha to stabilize the soil.

Bertha’s dive beneath Seattle

This graphic shows Bertha’s relative depth to the surface as she tunneled under downtown Seattle. The deepest she got was around First Avenue and Virginia Street, where the crown of the tunnel will be approximately 215 feet below the surface.