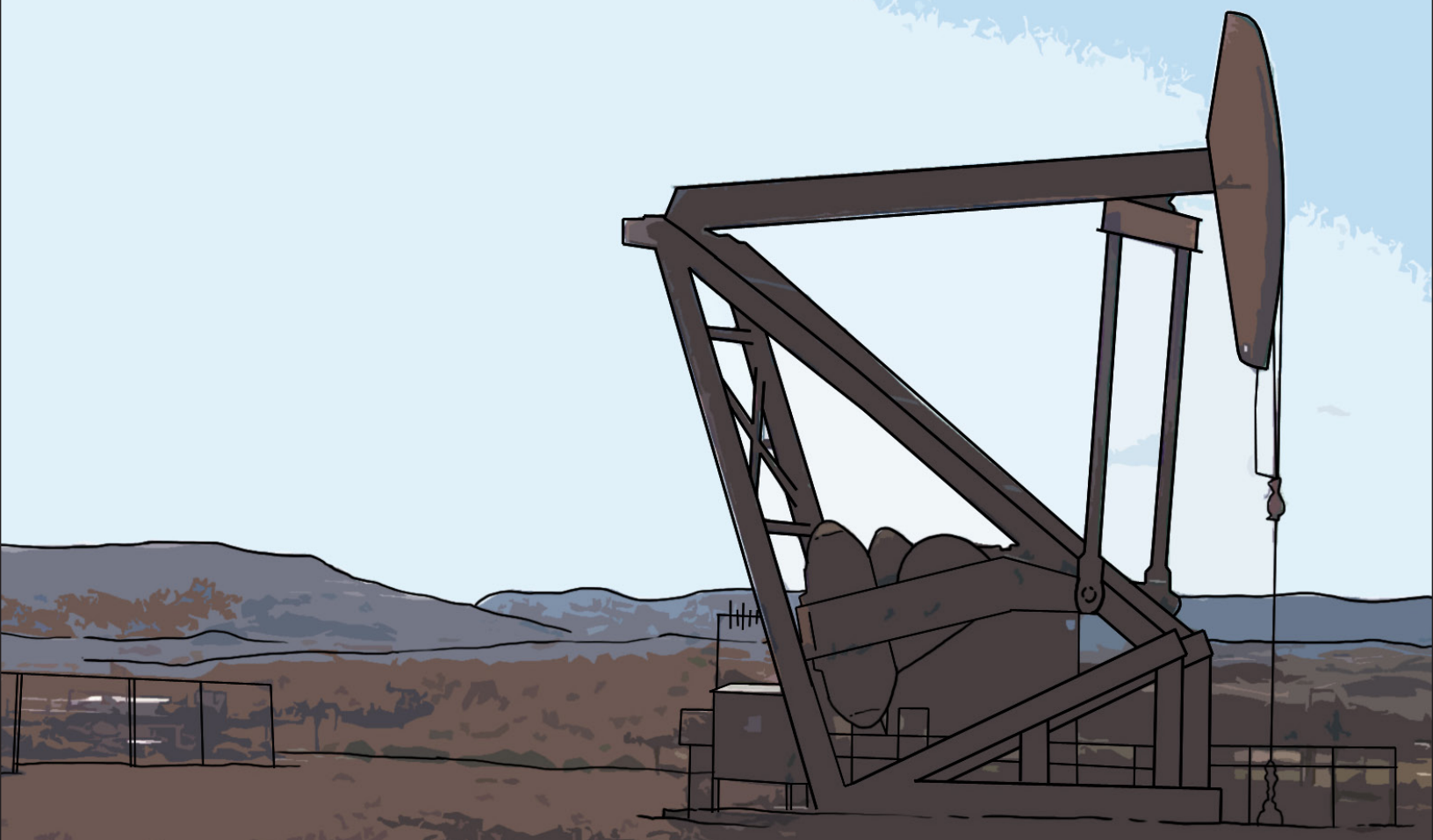
Oil Fields of North Dakota Coloring and Activity Book



Michael Ziesch and Alison Ritter

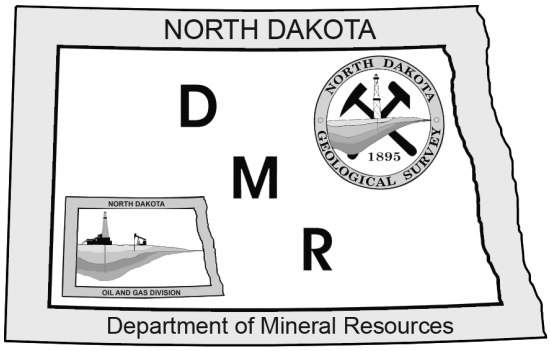
Illustrated by Becky Barnes

North Dakota Geological Survey
Educational Series 34

Oil Fields of North Dakota Coloring and Activity Book

Michael Ziesch and Alison Ritter

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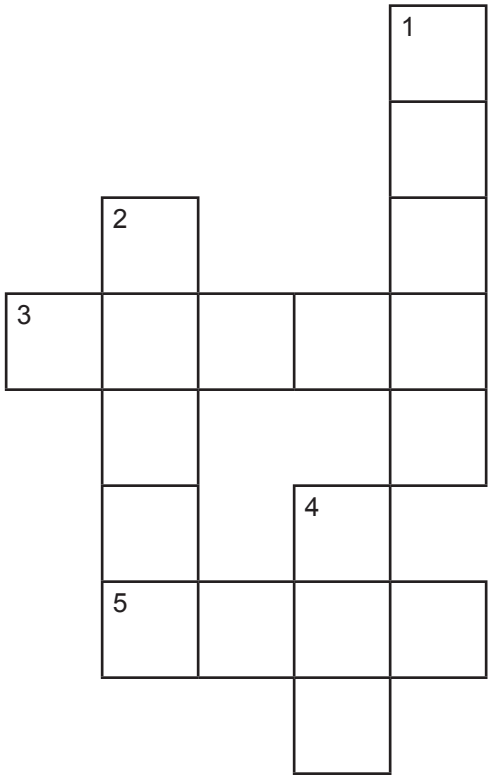
North Dakota Geological Survey
Educational Series 34
2018



Hi, I'm Inspector John Bobrick and I'm here to take you on a tour of the Bakken oil fields in North Dakota. Why, you ask? Well, did you know that oil and gas are very important resources, and that products made from oil and natural gas are all around us? Not just the gasoline that makes our vehicles go or the natural gas that warms our home, but in lots of other things we use every day. Let's take a look at how oil and natural gas are produced safely and efficiently from the oil fields in North Dakota.

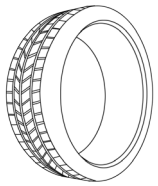
Complete the crossword puzzle by identifying products that we use every day that are made in part from oil.

CROSSWORD PUZZLE



CLUES

1. Your car drives on these:



2. You wear these on your feet:



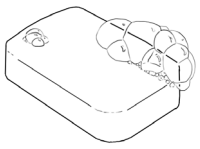
3. Used to call people:



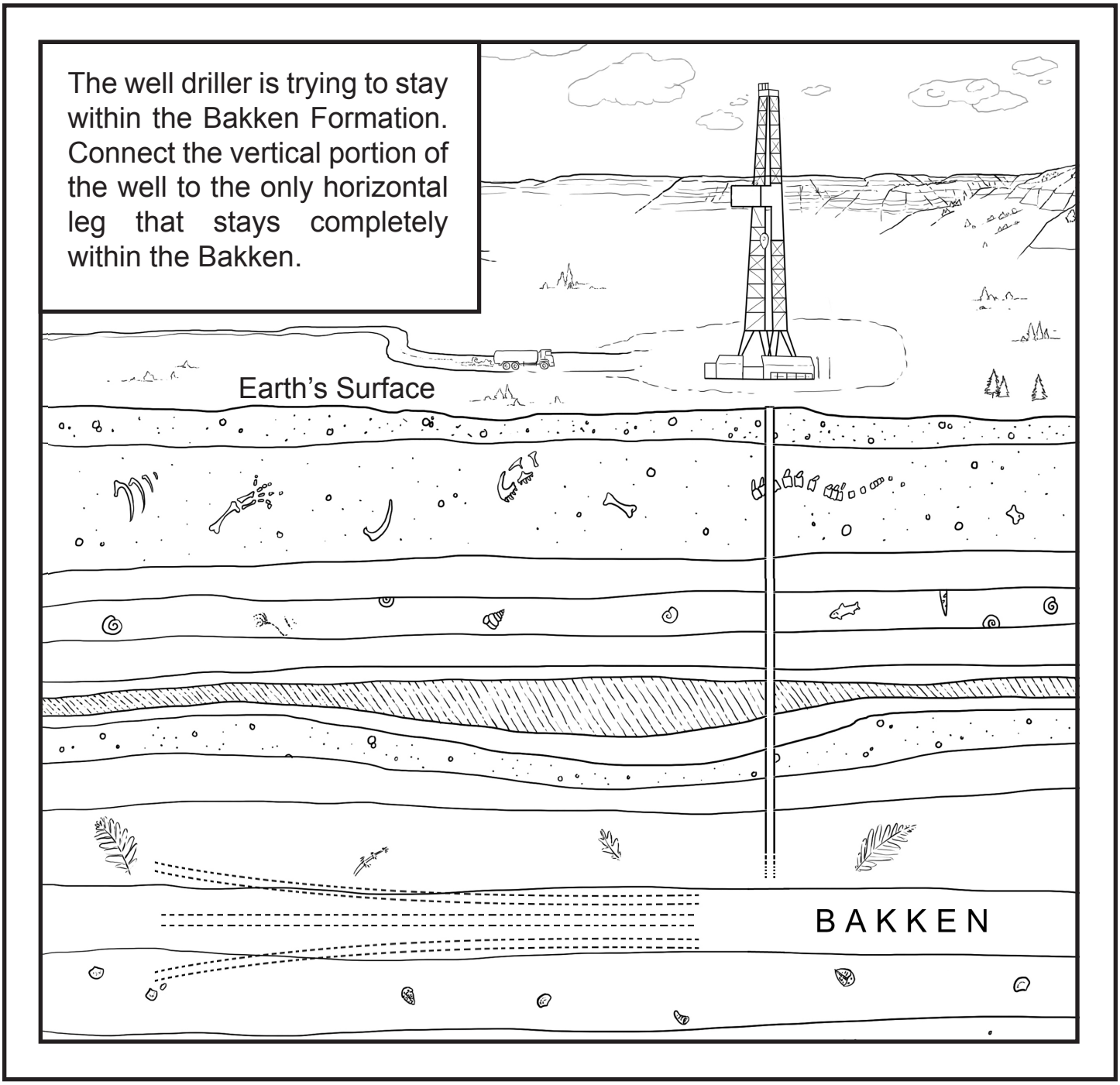
4. Most cars use this to drive:



5. You use this to get clean:



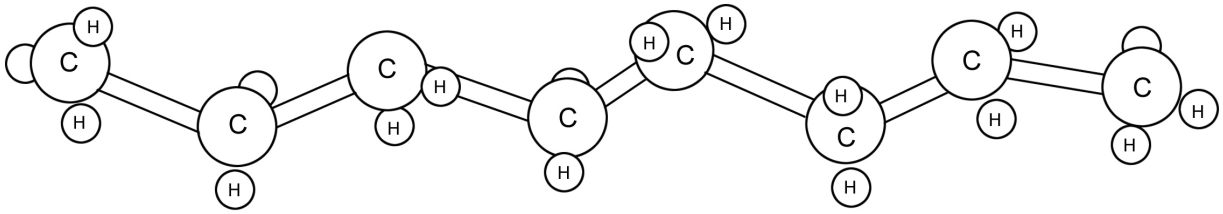
No oil field tour would be complete without a brief history lesson, so let's start with one. The history of oil and gas in North Dakota really starts hundreds of millions of years ago, back even before the dinosaurs, but we can start with the part where people get involved.



The search for oil in North Dakota started in the early 1900's but wasn't successful until 1951. The Clarence Iverson #1 well, was the first well to successfully produce oil in North Dakota. It was drilled just outside of Tioga, ND. The success of the Iverson well kicked off the first ND "Oil Boom" which lasted for about 10 years. The second boom happened around 20 years later in the early 1980's. The third boom or the "Bakken Boom" started in 2006.

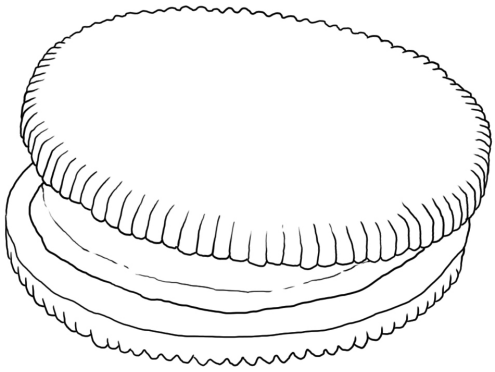
What is oil and natural gas?

What we call oil and natural gas are commonly known as fossil fuels because they are formed from the remains of prehistoric plants and animals. Oil and natural gas are called hydrocarbons by scientists because they are made up of chains of hydrogen and carbon atoms. These hydrocarbon chains are created when temperature and pressure conditions are just right for the organic matter trapped within a rock to breakdown and transform into hydrocarbons. Did you know that it takes millions of years for the remains of plants and animals to transform into oil? Or that oil and gas are found deep underground and trapped inside of rocks like the Bakken Formation and not in big underground pools?



What is the Bakken Formation?

Think of the Bakken Formation like your favorite chocolate sandwich cookie. Two hard, brittle cookie layers and the middle filled with good stuff (the cream filling!) The chocolate pieces are Bakken shales and the middle Bakken is the cream filling or the “good stuff” where oil is taken from!



How are oil and natural gas used?

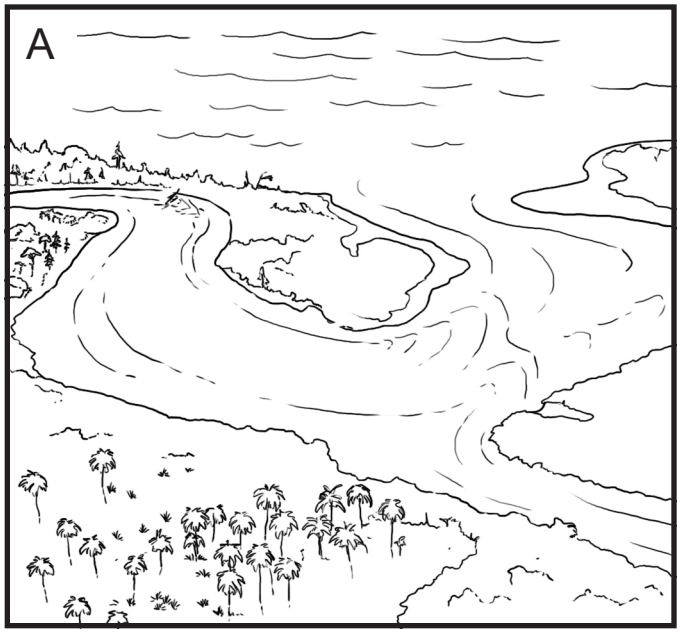
Both are products that can’t be used unless turned into something else. For example, oil must be refined into gasoline that we use in cars and natural gas can be used to heat homes or broken down to make plastics.

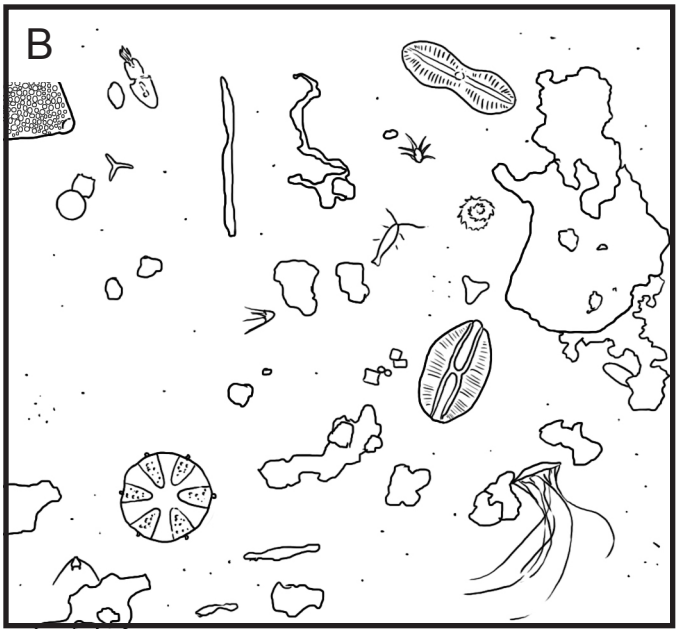


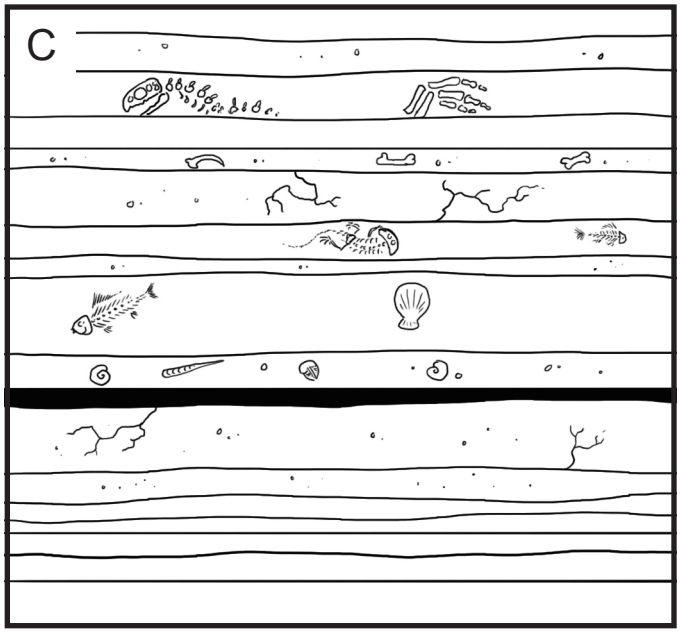
How were Oil and Natural Gas Formed?

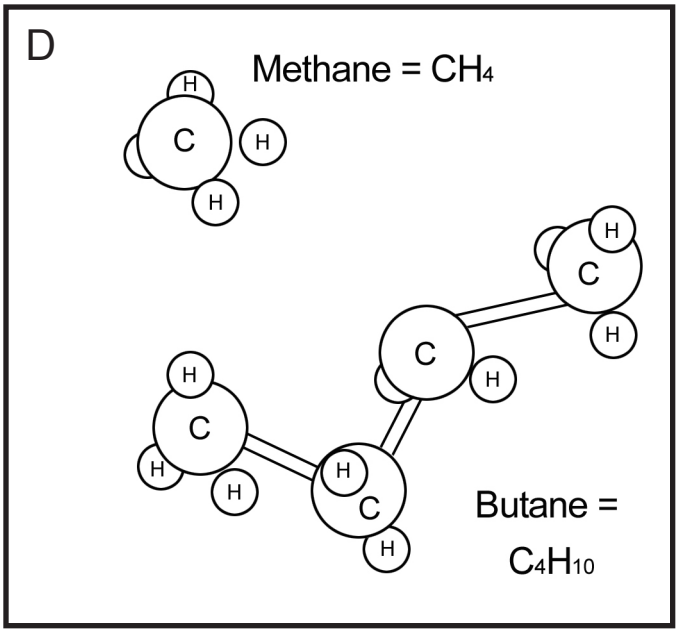
Millions of years ago, North Dakota did not look like it does today. In fact, throughout much of its history North Dakota was at the bottom of a sea.

When the remains of small or microscopic marine organisms (plants or animals like algae and plankton) living in those seas died, they sank to the bottom of the sea creating an organic rich mud.









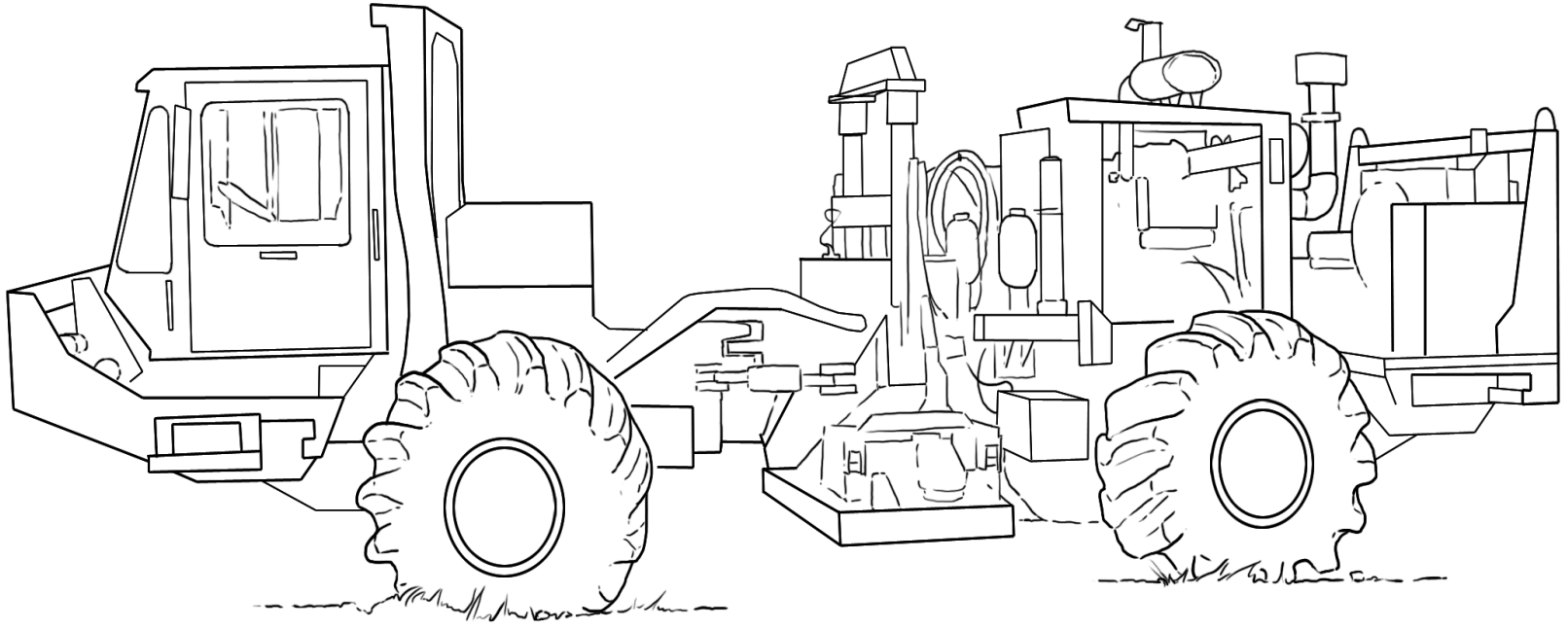
Over millions of years more mud and sand was deposited on top of the organic-rich mud (black layer). As the organic-rich mud was buried deeper, both temperature and pressure increased and the mud turned into rock.

Under the right conditions (enough time, temperature, and pressure) the organic material in the rock can breakdown and transform into hydrocarbons.

Now that you know what hydrocarbons are and that they are found trapped in rocks buried deep underground, you might be wondering how people ever figured out where to drill an oil well. The search for oil typically begins with a seismic survey or what a scientist would call geophysical exploration.



Here we have a Vibroseis truck. A special type of scientist called a Geophysicist will use a truck like this, or a shallow hole with an explosive charge, to create a loud sound to send sound waves traveling into the ground. They will then listen for that sound using a string of geophones. A geophone is a small tool that can detect or "hear" the sound waves as they bounce off of rock layers and back to the surface.



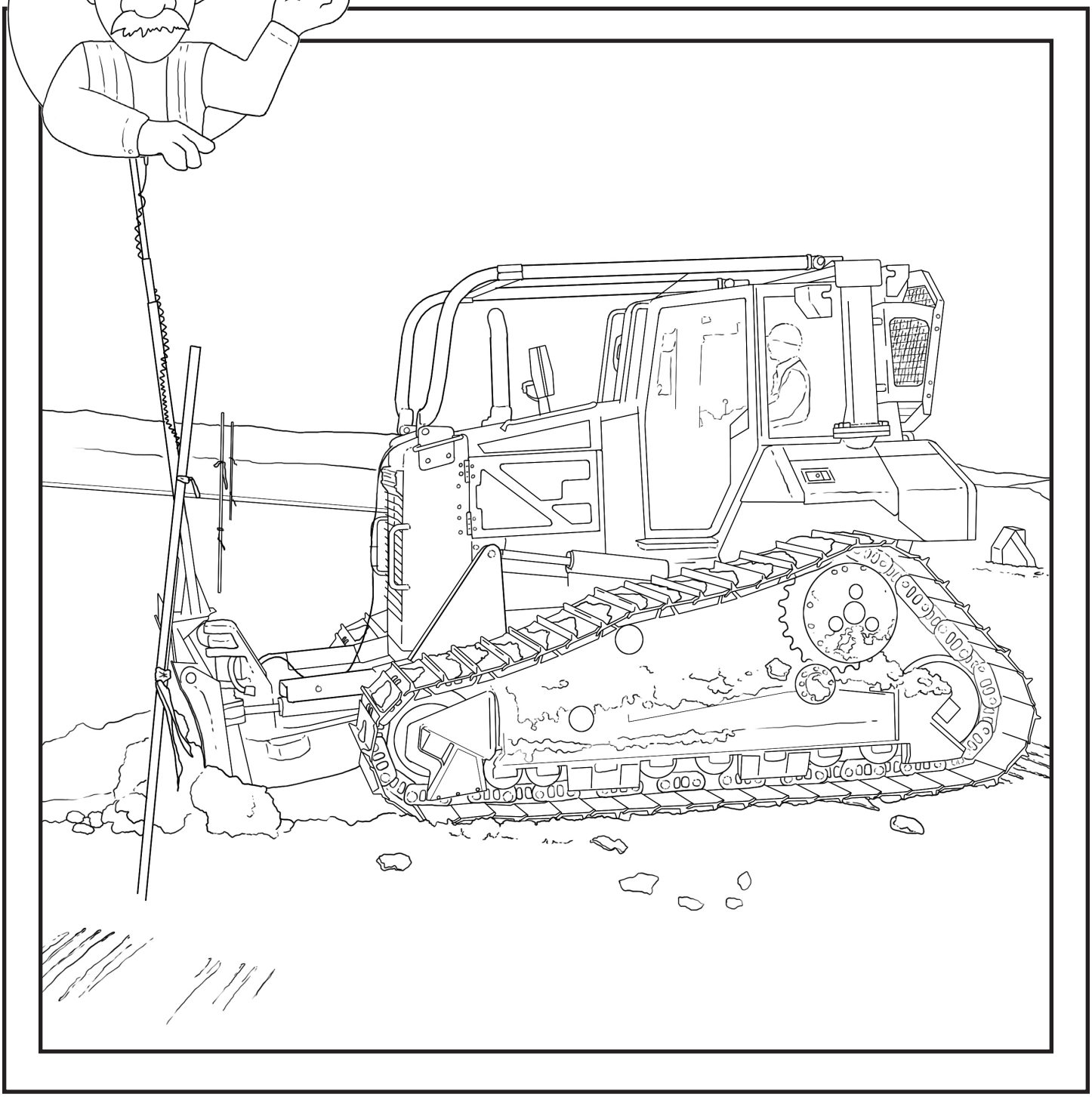
Part of my job as an inspector is to visit a location like this where geophysical exploration is taking place. I make sure the company is complying with the terms of the exploration permit, that they are protecting surface and ground water, and that they have permission to be on the land they are exploring. When they are all done, I will come back to make sure any land that was disturbed during exploration is properly reclaimed (or returned as close as possible to how it was before the seismic survey).

Search through the letters to find the hidden words. They may be horizontal, vertical, or diagonal.

BLAST
DEPTH
DISCOVERY
EARTH
ENGINEERS
EXPLORE
GAS
GEOLOGISTS
GEOLOGY
LAYERS
OIL
RECORDERS
RECORD
RESERVOIRS
ROCK
SEISMIC
SHOT HOLES
SURFACE
TRUCK
WAVES

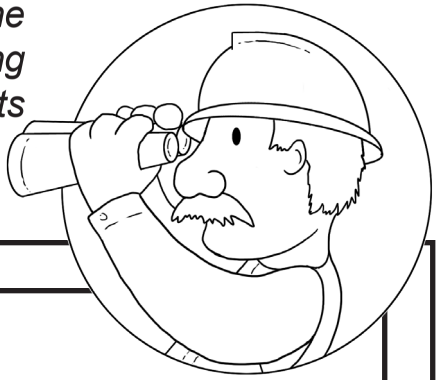
N M U L I X E O Z U R S L N C N X X B T X Z Y S R
J U T W Y C N I F T N D Z I L W B R S S U C U A E
X O E D K K T L C U E T H X C D X D Z O E O A O S
F F N H M O K D K J P W S O L U I U T K J J C D E
N U N U O E X P L O R E W G E O L O G Y M A E E R
Z O B S Y D T Z Q U F S Y B V H T Q Q S S M B V V
V W E W M A W S Z G R U R E C O R D E R S H V T O
E W T O O W N P T H A P P R U O S V L R V Y J C I
H R U M R G Y R B F I E P E S G E Y O C L I F H R
D E H H T X W A C G C R O A V W A B G U L A C Q S
X C H X R K X J S E C Y Z P X Y J G Z U M V T W E
U O S O L L S S V O F X U H R S L G K D O Q S M F
U R N R I A W V H L C B K E Z N T C M Y T V F D X
F D P Y U B Y E J O J B V I K S U R F A C E P E T
O L A D A E L E S G T O O P R R X T X L E W Q P W
N Z R H C S G A R I C H P H T E D V H C H A N T D
Q R O W S O A P S S X P O H D Q L D B M X T R H J
L P C O Y E S S I T V T K L H V E M Y W M A V T Q
W G K Y W W C D L S I V X J E N G I N E E R S D H
M E Y P U J I E M M B T S E I S M I C B J R R O B

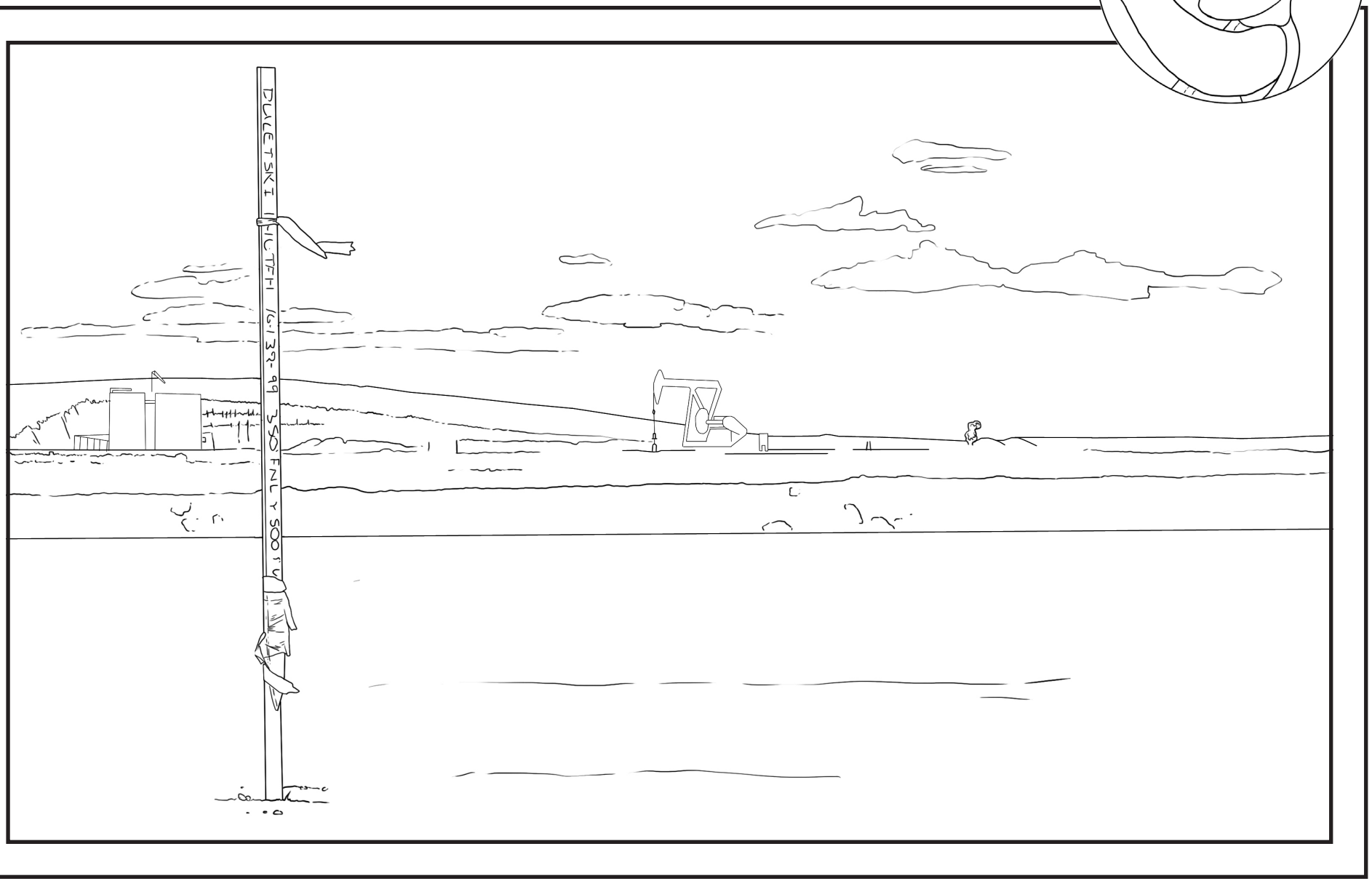
My job here is to make sure the site is constructed according to its permit conditions. Did you know that in its first year, a new well site will have more than 1,200 trucks visit the location?



Here we are at a new location or drilling pad as it is being built. A small bulldozer works in between stakes which mark the spot where oil wells will be drilled. The work crew will level and compact the location then they will cover it with an orange rock commonly called scoria (though my geologist tells me it is not really scoria but a baked clay rock called clinker).

This is a staked location on a finished well pad, just waiting for the well to be drilled. In the background you can see a pump jack (right) on an already drilled well, which is producing oil and water and storing it in the tanks (left) on the location. The produced natural gas gets sent down a pipeline to a natural gas plant.





Key to a Typical Drilling Rig:

1 Crown Block

2 Mast

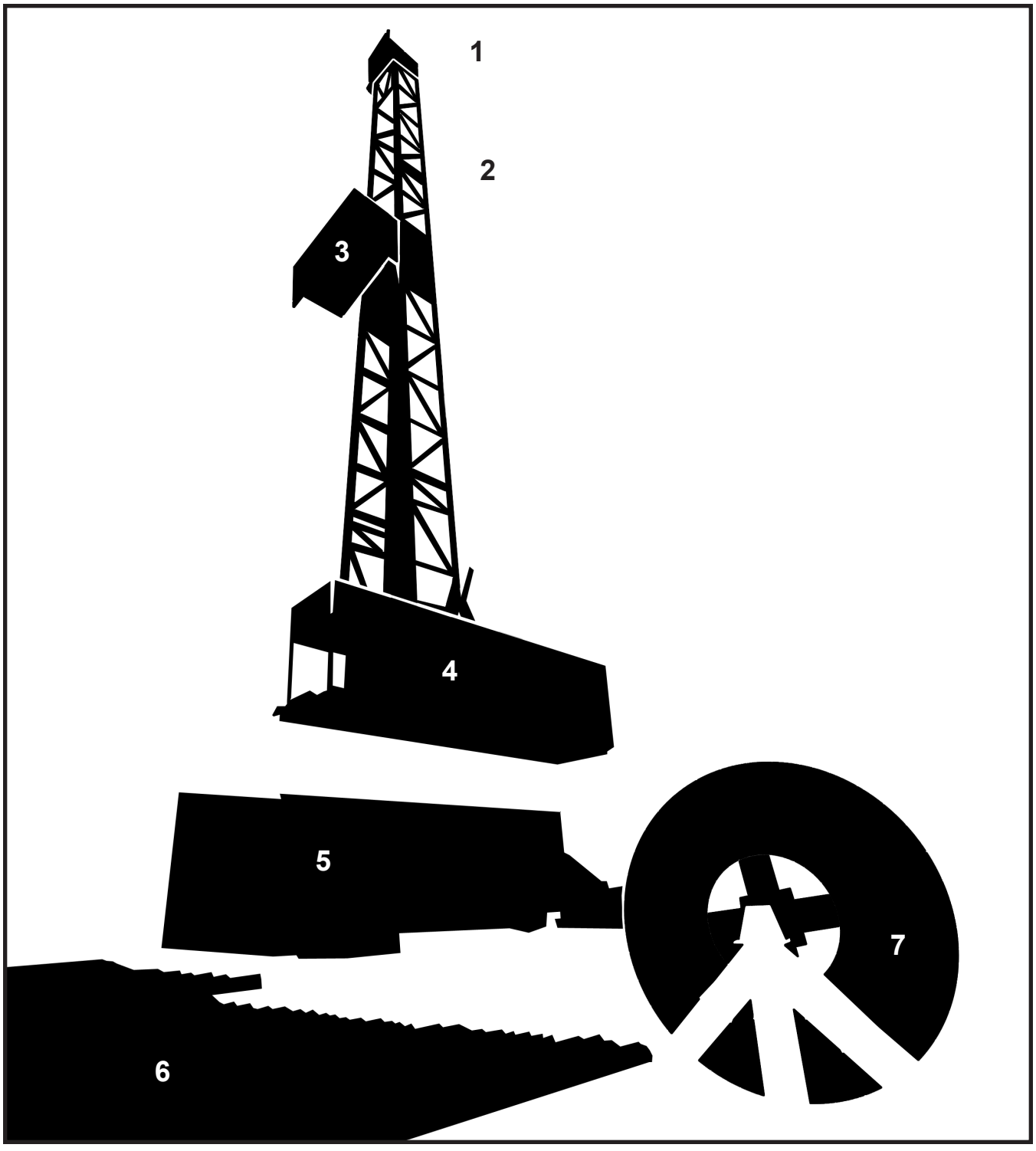
3 Monkey Board

4 Drillers Cabin

5 Substructure

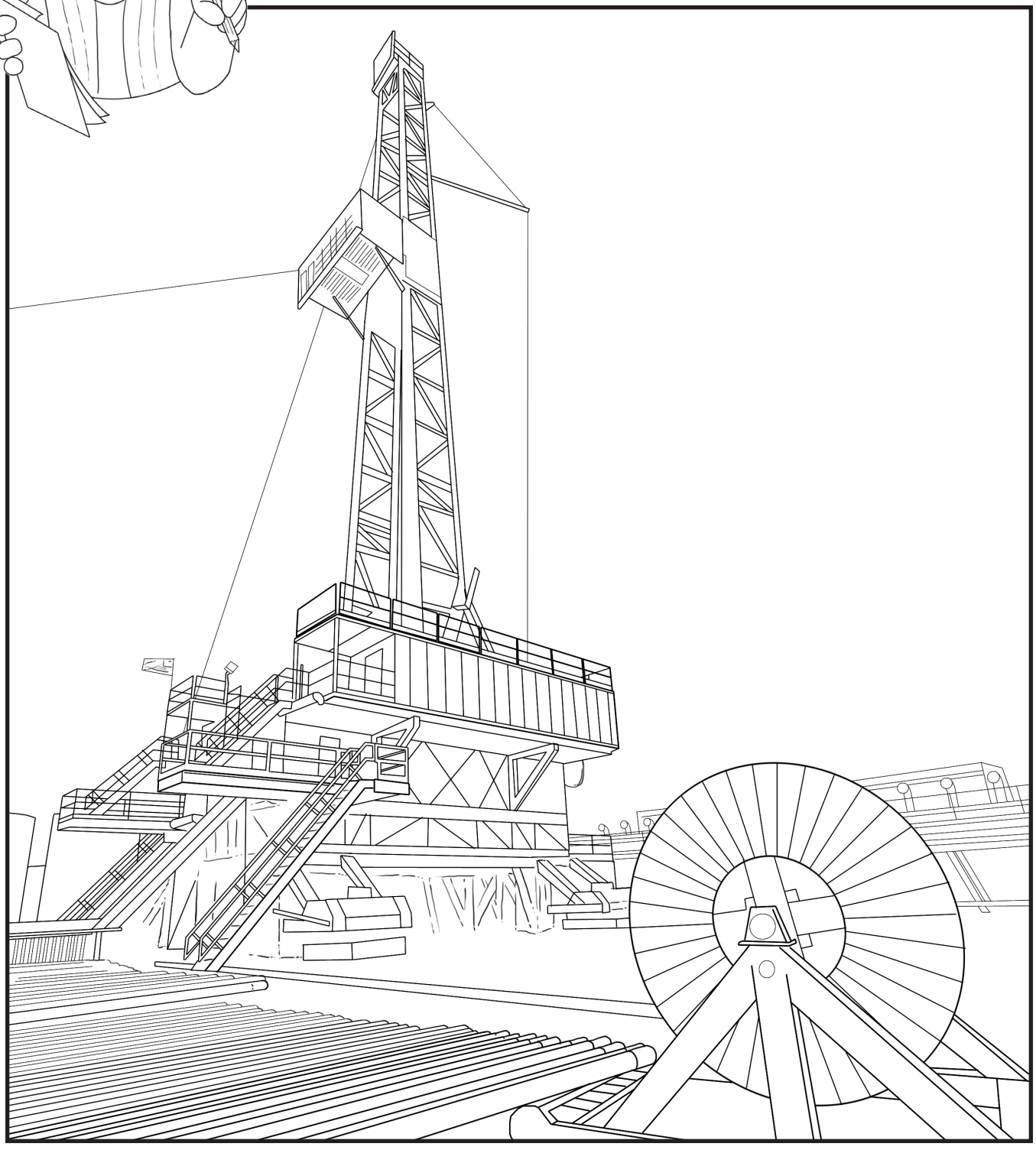
6 Drill Pipe

7 Wireline Spool

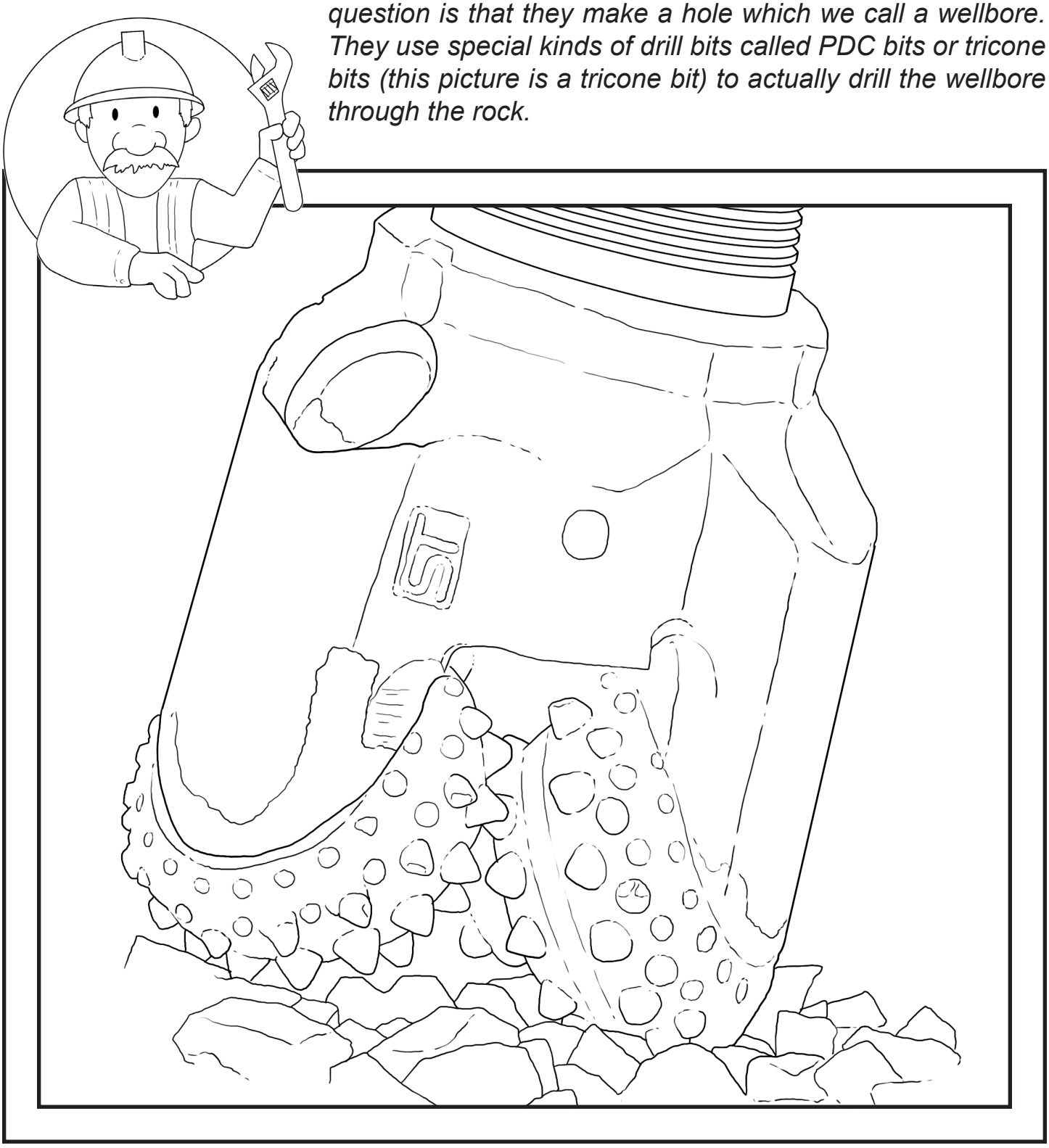


Here we see a drilling rig which is a large machine that people use to actually drill and construct an oil well. When the drilling rig is on location I try and visit once or twice per week to make sure that the people running the drilling rig are protecting the environment and that they are drilling the well the same way that the approved permit allows them to.



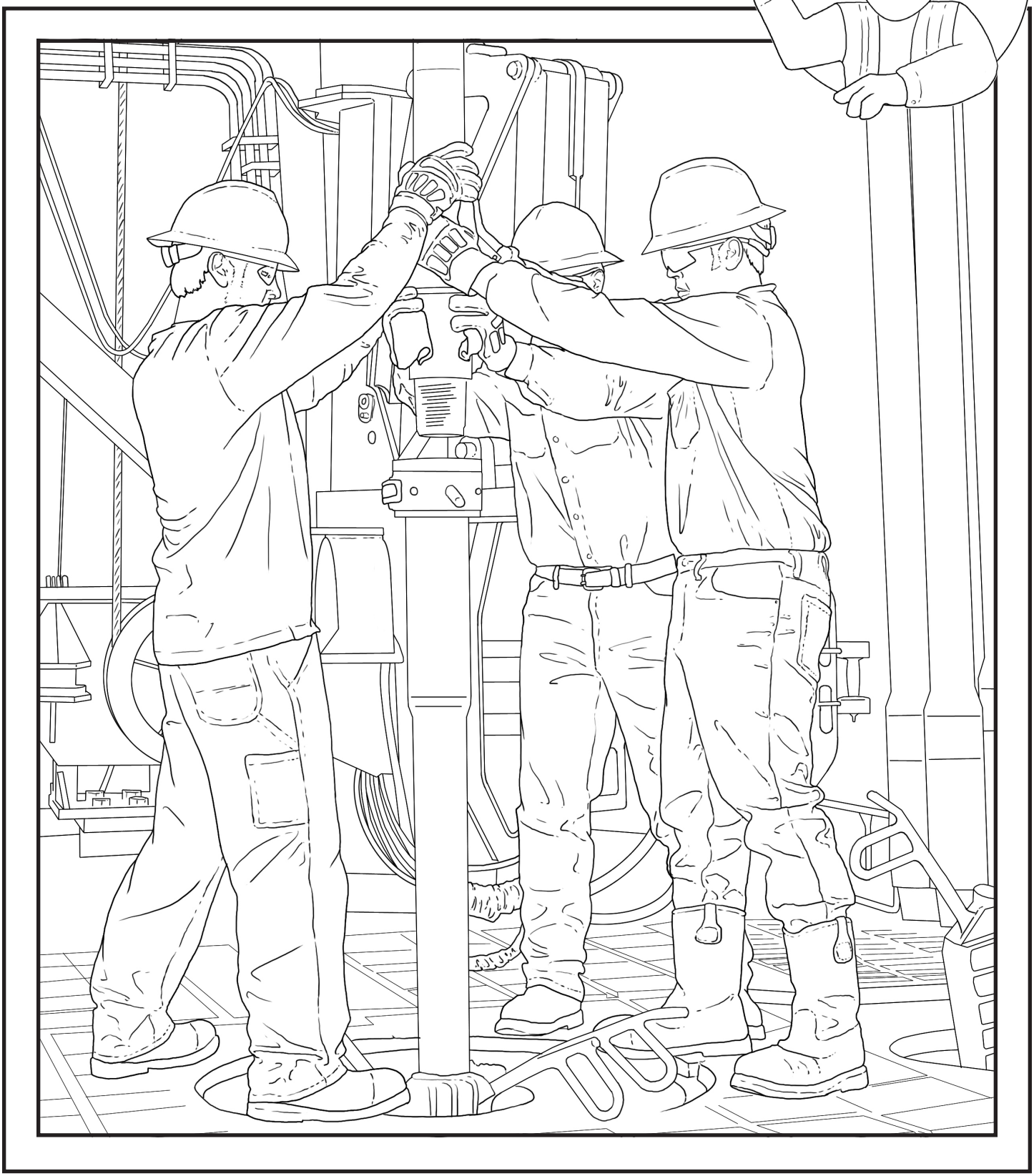


So, after learning that oil comes from rocks and seeing that big drilling rig, you might be wondering how that big rig gets down to those oil filled rocks. The easy answer to that question is that they make a hole which we call a wellbore. They use special kinds of drill bits called PDC bits or tricone bits (this picture is a tricone bit) to actually drill the wellbore through the rock.

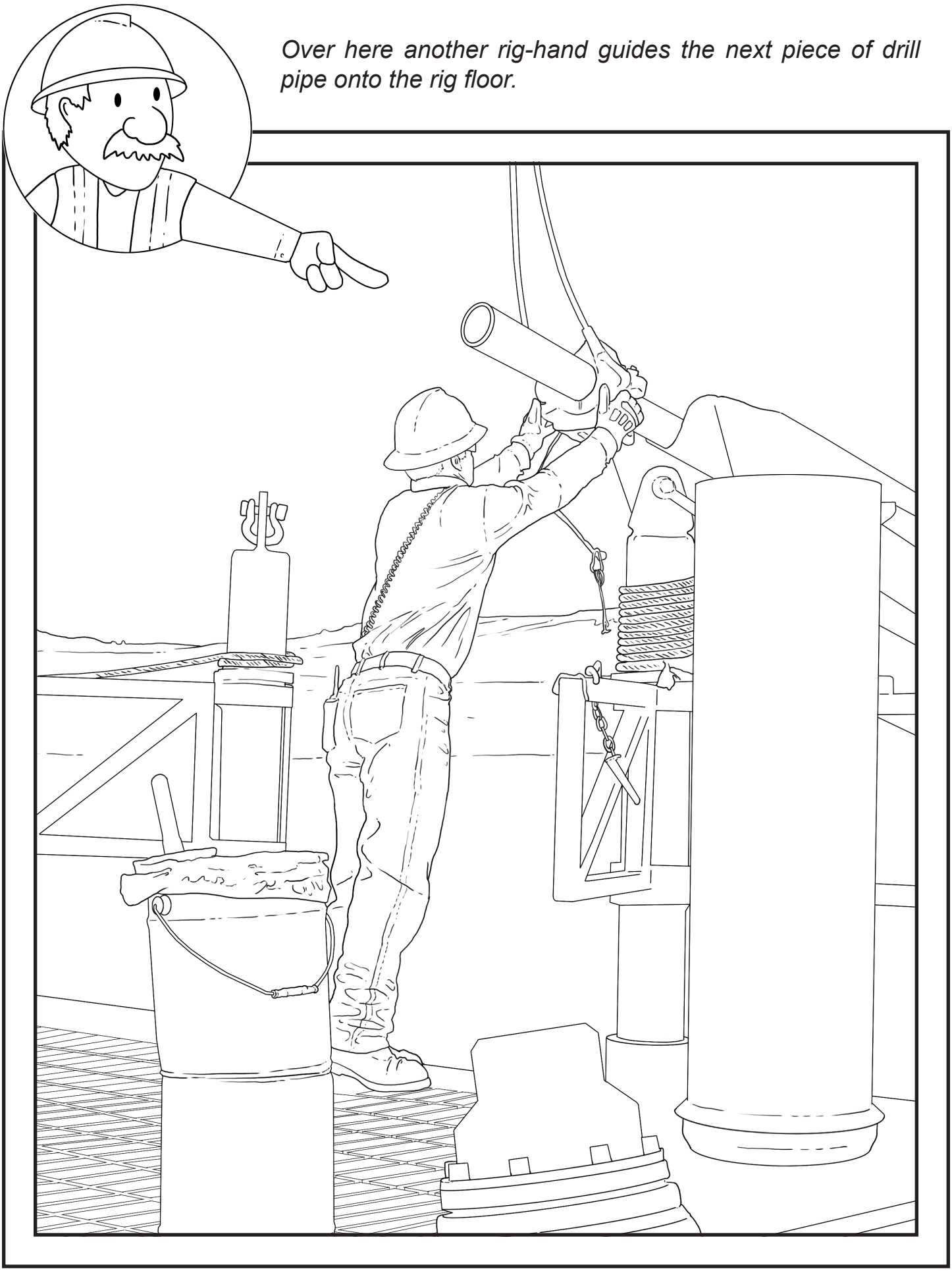


Drilling through solid rock is hard to do, these special drill bits don't cut the rock like a wood cutting drill bit does. Instead of cutting a hole in the rock they actually grind the hole in the rock by breaking off small pieces of rock as they turn the bit.

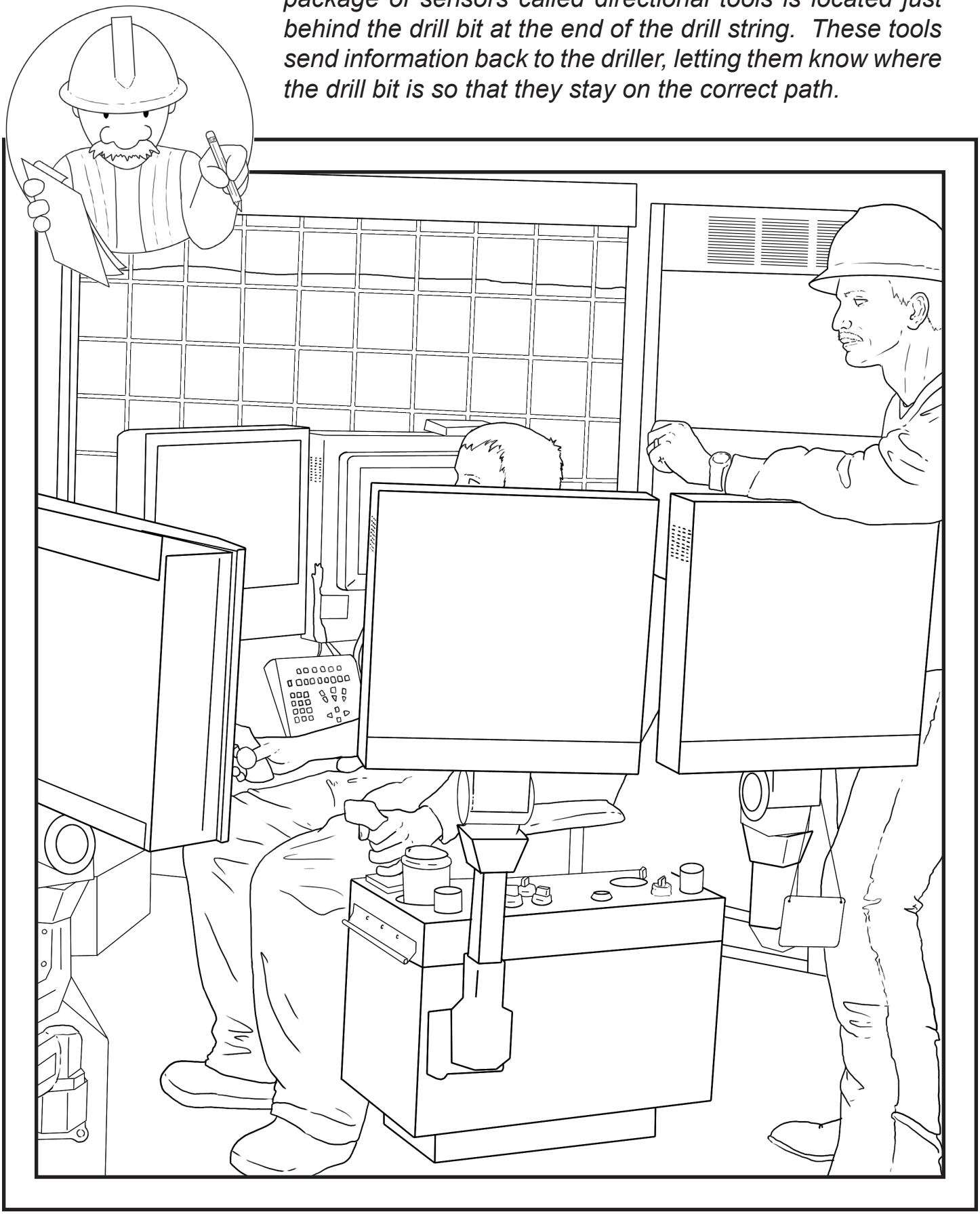
Here we see workers on a drilling rig floor. They are connecting another piece of pipe together with other pipe already in the ground to create what is called a drill string. The drill string connects the drill bit to the drilling rig as it works deep below ground while drilling the well.



Over here another rig-hand guides the next piece of drill pipe onto the rig floor.



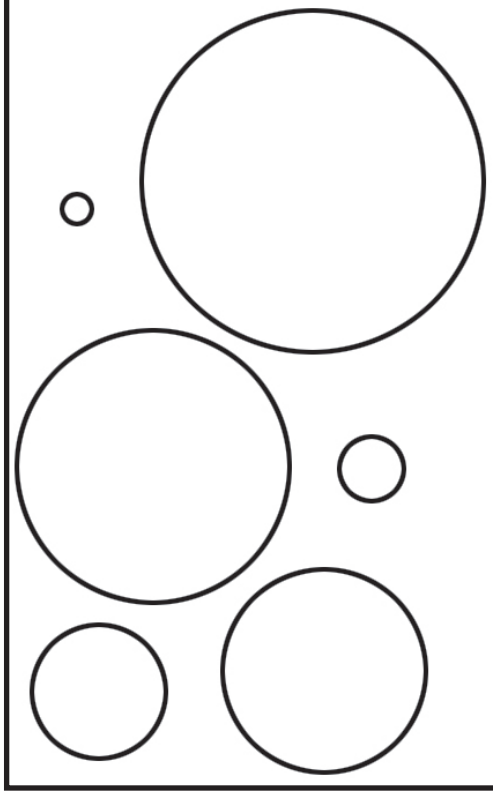
Here we are in the rig control room, or "doghouse." From here the driller uses joysticks to drive the bit as it drills. A package of sensors called directional tools is located just behind the drill bit at the end of the drill string. These tools send information back to the driller, letting them know where the drill bit is so that they stay on the correct path.

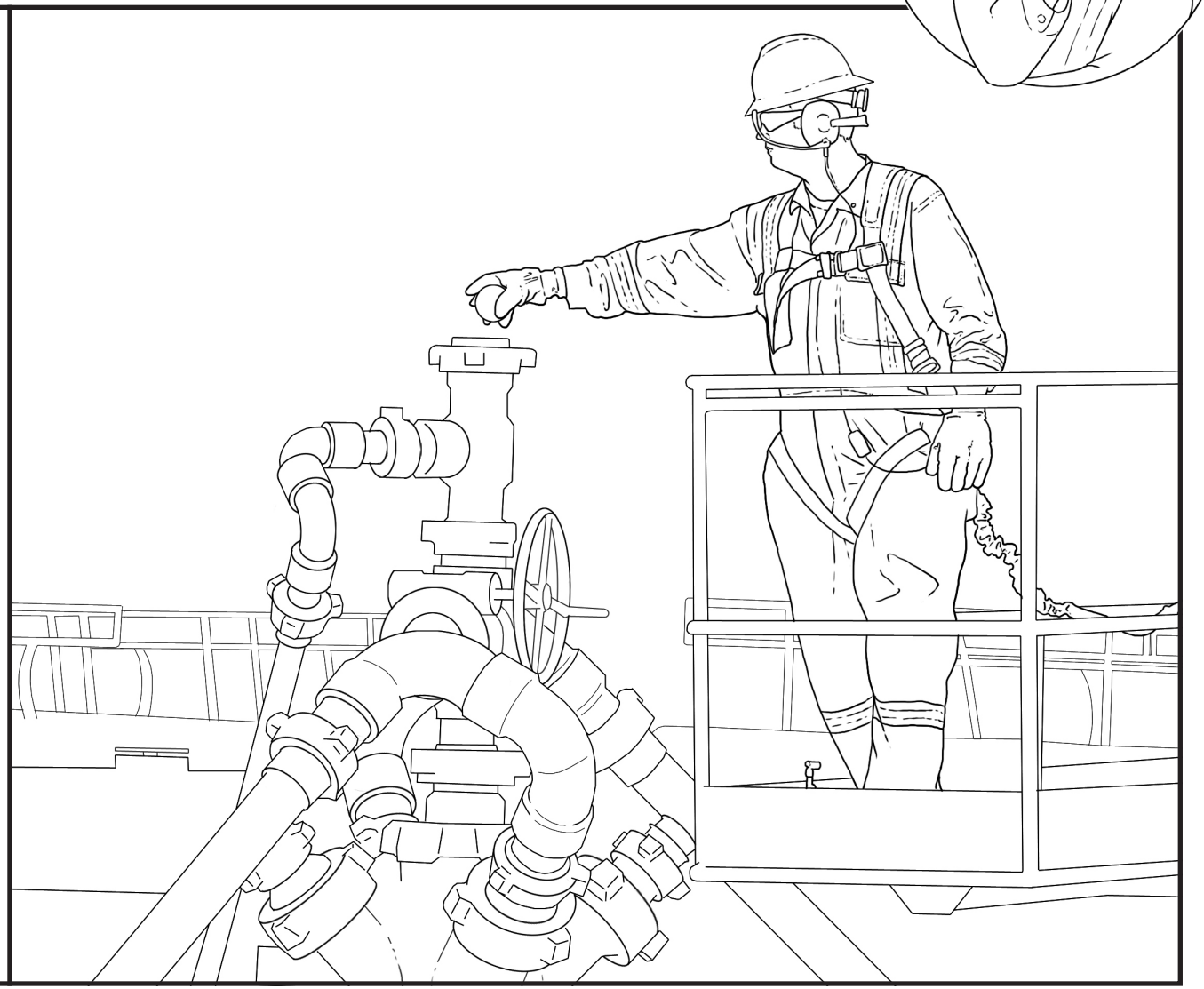


This is a well site where hydraulic fracturing, or "fracing," is taking place. Basically, crews send millions of gallons of water, and millions of pounds of sand, down the well to break open the rock, which helps oil flow. This process is done in many stages down the well. This worker is dropping a ball down the well to seal off one stage from another.

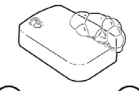


Help the technician put the frac balls down the pipe in order from smallest to largest. Write their number, from 1-6, inside or next to each ball.

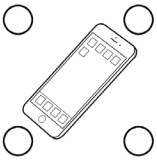
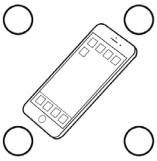




Take turns with another player to connect the well sites, vertically or horizontally. The player who draws the last line of a square gets a point. If the square contains an item made from oil it's worth two points. The player with the most points at the end wins.

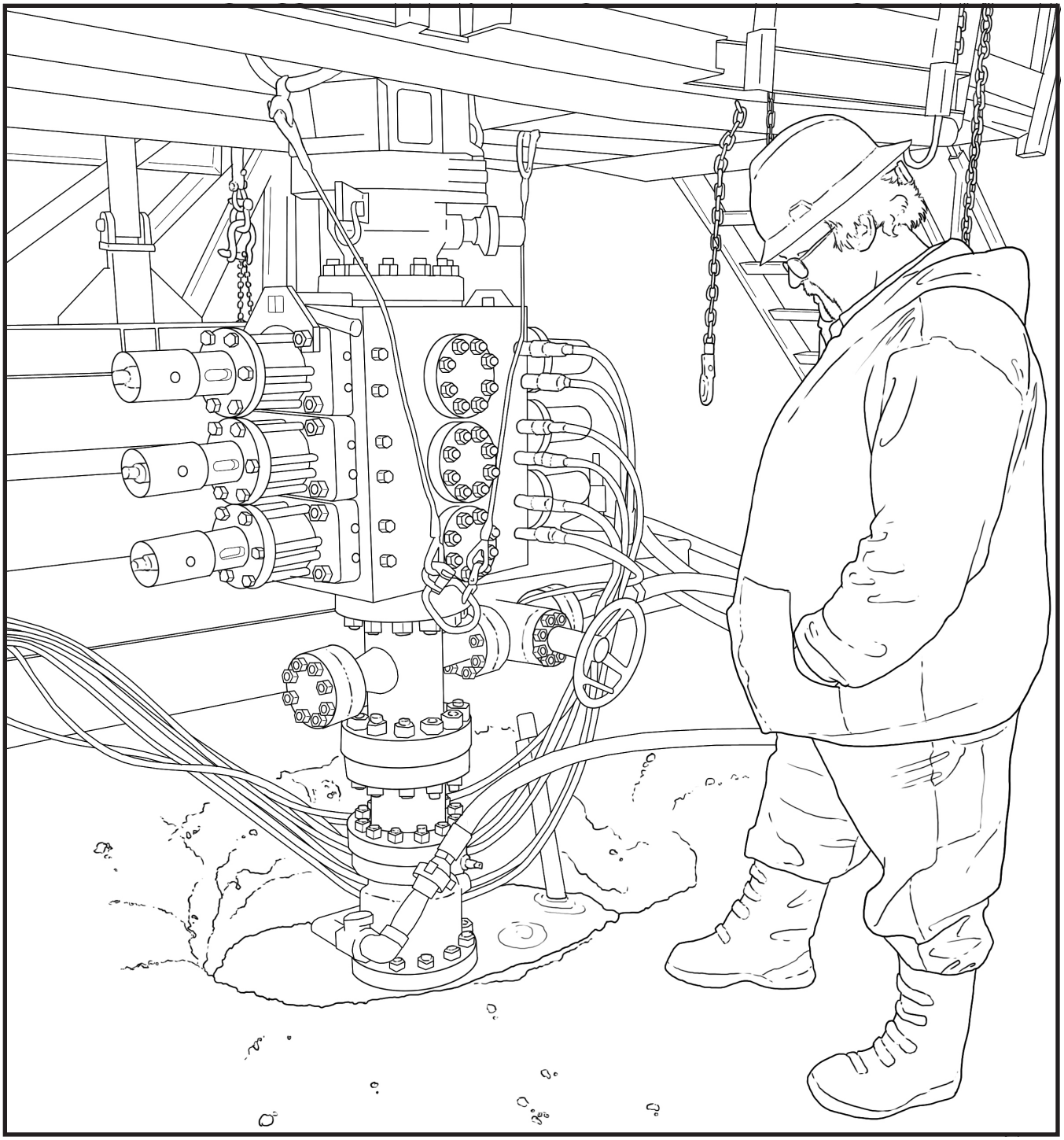






Today I am visiting a workover rig. This smaller machine helps "clean out" the well before it begins producing oil and natural gas. It can also be used to help clean or fix the well during its lifetime.



An inspector looks over a blowout preventer (BOP) while a well is being drilled. More than two miles below the surface, oil and gas reservoirs contain immense amounts of pressure. During the drilling process, well pressure is carefully monitored so it does not lead to an uncontrolled release of oil and gas. If a kick of pressure occurs, (think of this like when you hiccup) a BOP uses different valves and rams to close off the well to try and stop the uncontrolled release. In North Dakota, blowout preventers are required and inspectors are on site to make sure they are installed and tested.

Key to a Typical Well Site:

1 Pumpjack 2 Oil and Saltwater Tanks 3 Treater Shack 4 Scoria Well Pad



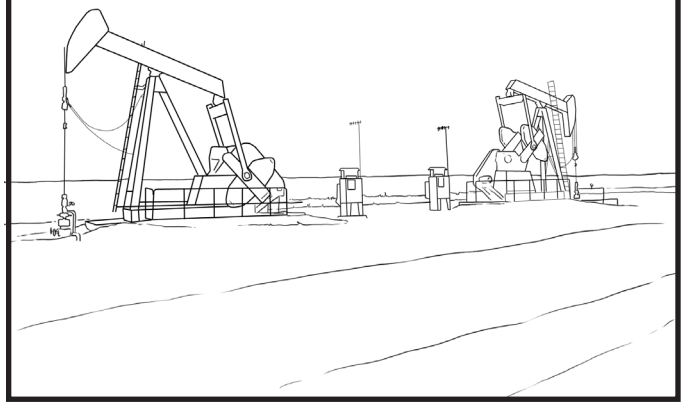


Oil and Gas Extraction

Almost all of the oil and natural gas in North Dakota comes out of the ground together with salty water. Think of this like getting a soft drink from a soda fountain machine, the oil would be the drink syrup, the natural gas would be the fizzy bubbles, and the saltwater would be the soda water.

Oil and natural gas are run through equipment called a heater treater. This equipment heats and separates the pop (oil) from the fizz (natural gas), and even separates the water, too!

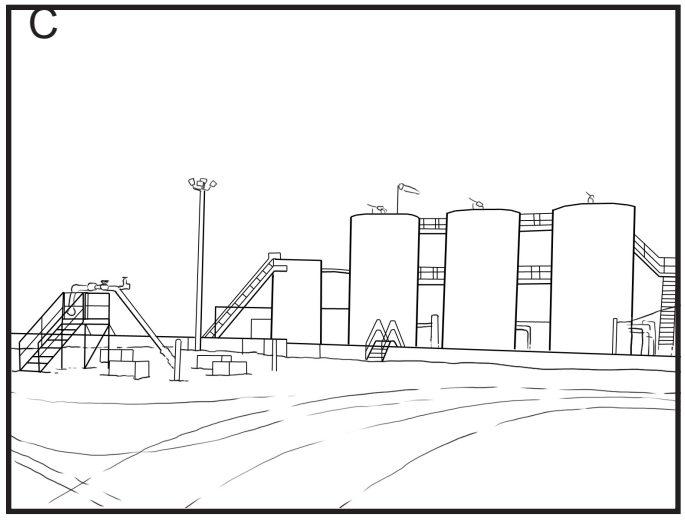
A



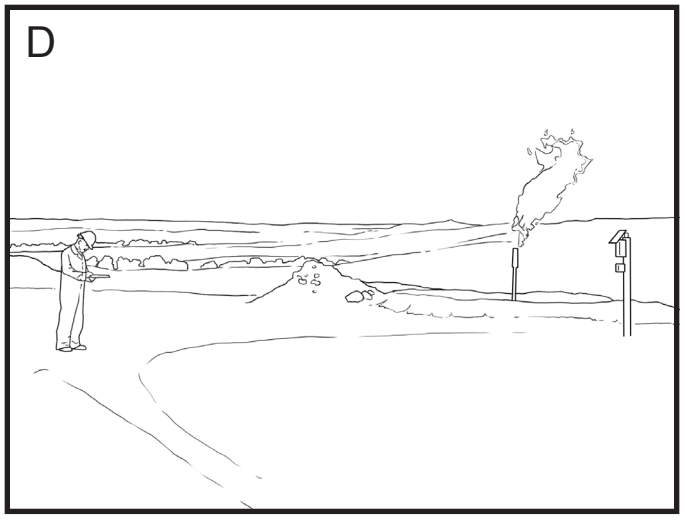
B



C

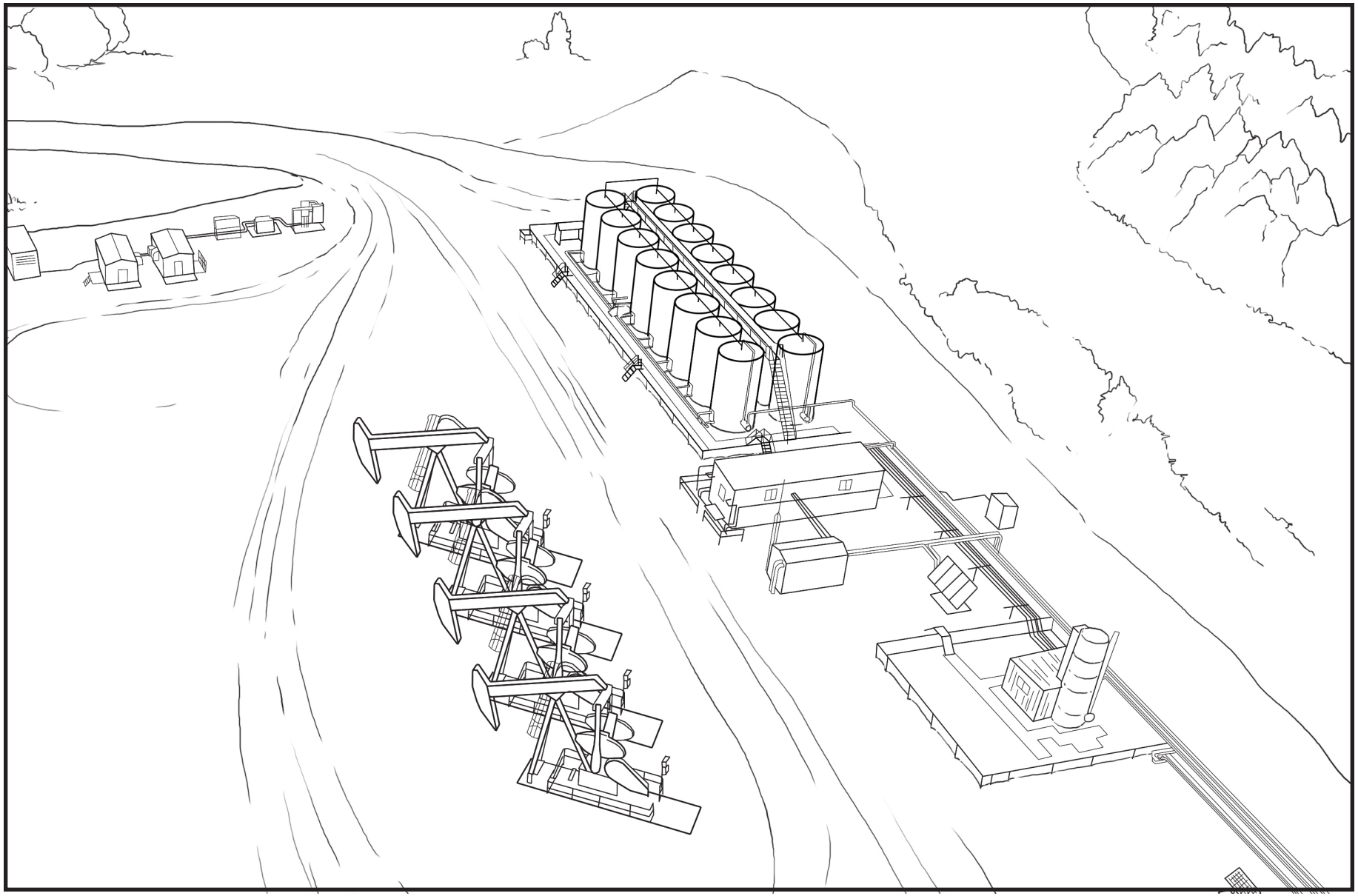


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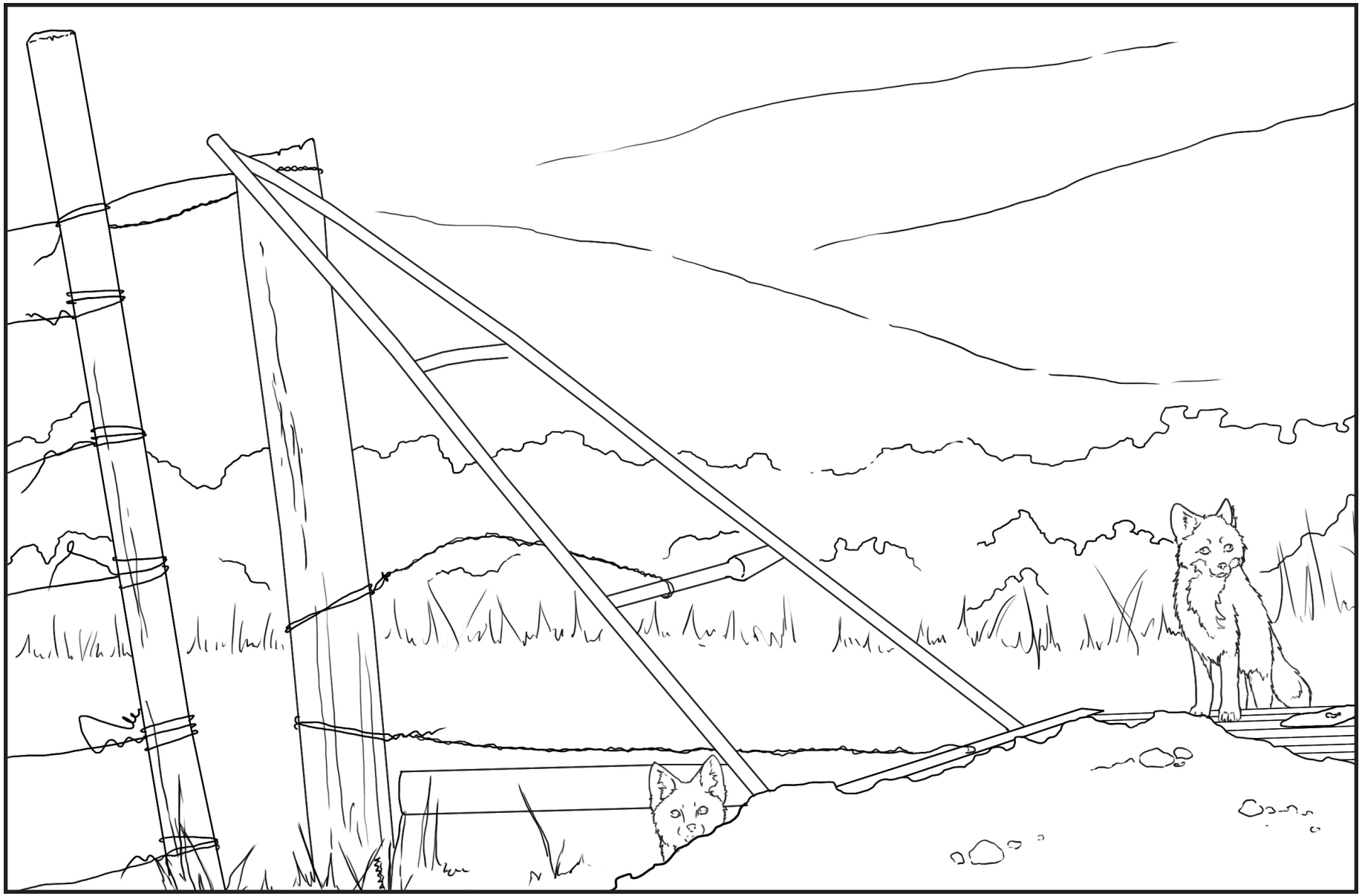


Water and oil run through pipelines to tanks on site for collection via truck or pipeline.

Natural gas is collected by pipelines. Sometimes the pipelines aren't big enough to collect all the gas, or for safety reasons, the gas must be sent to a flare stack to be burned off.



To be more efficient with the use of the surface, companies will drill multiple wells from one location. This is known as a multi-well pad.



Two curious foxes stand at the entrance to an oil well site. Oil production, wild animals, and agriculture co-exist in North Dakota. Each is an important part of western North Dakota.

Wildlife can be found all over North Dakota! Match the paw print on the left to the animal that made the track!



Beaver



Bear



Fox



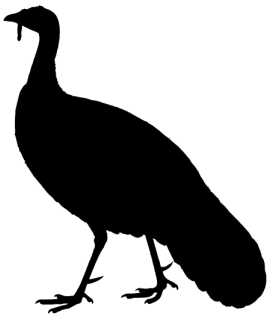
Deer

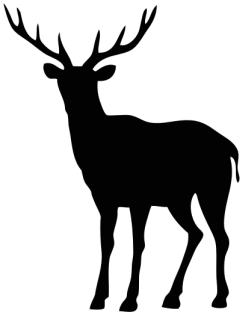


Turkey

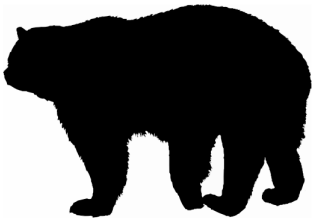


Squirrel



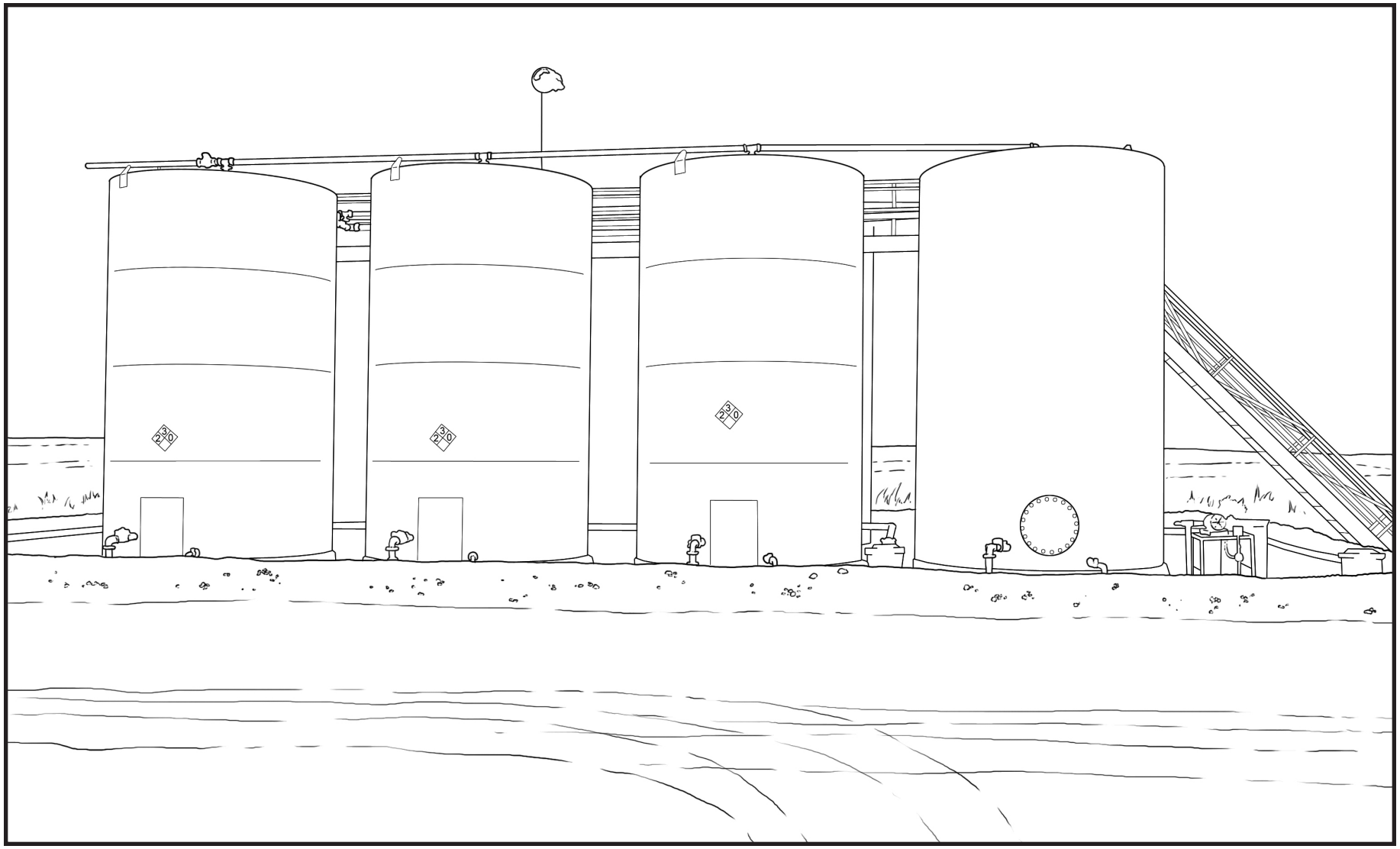






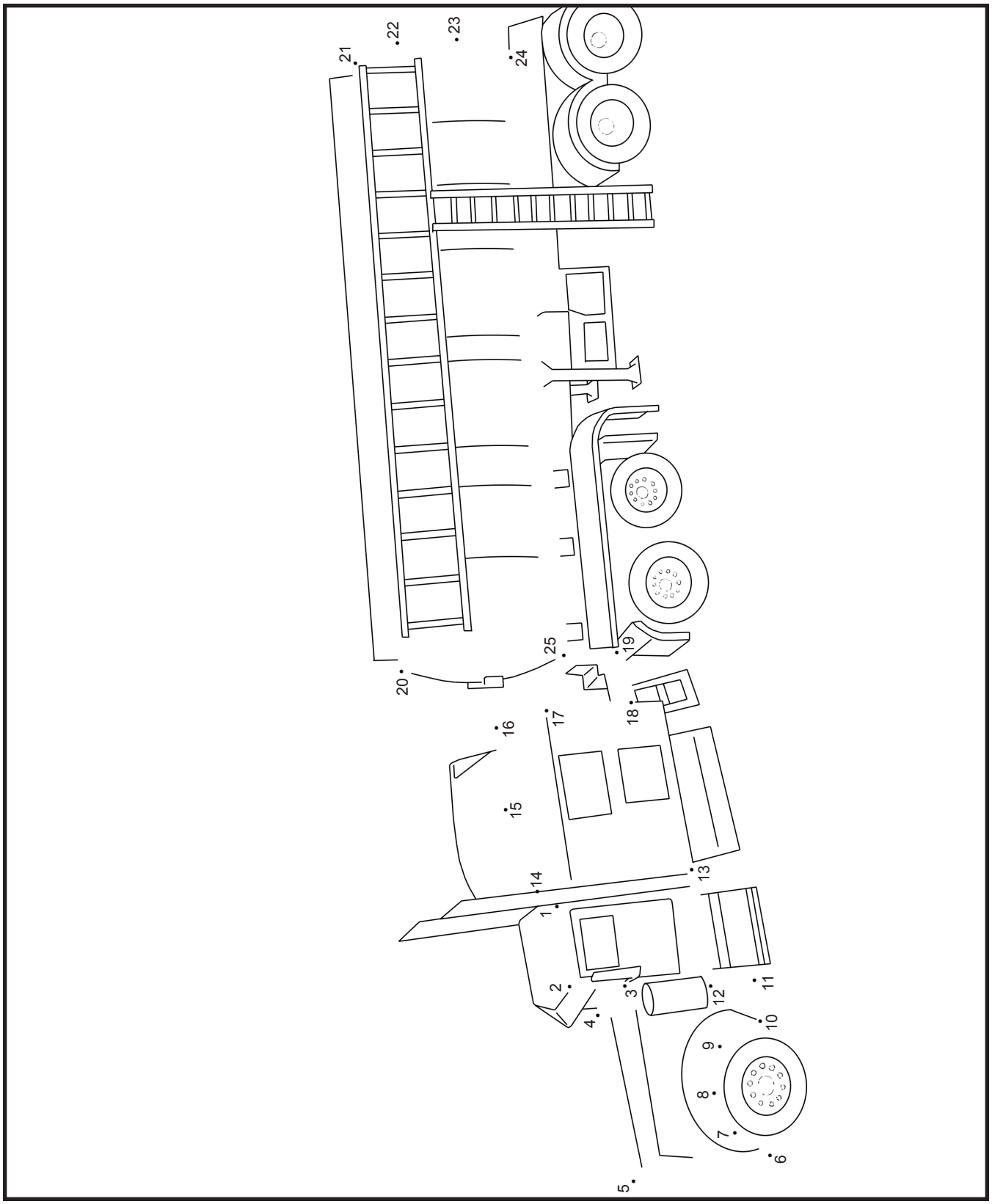


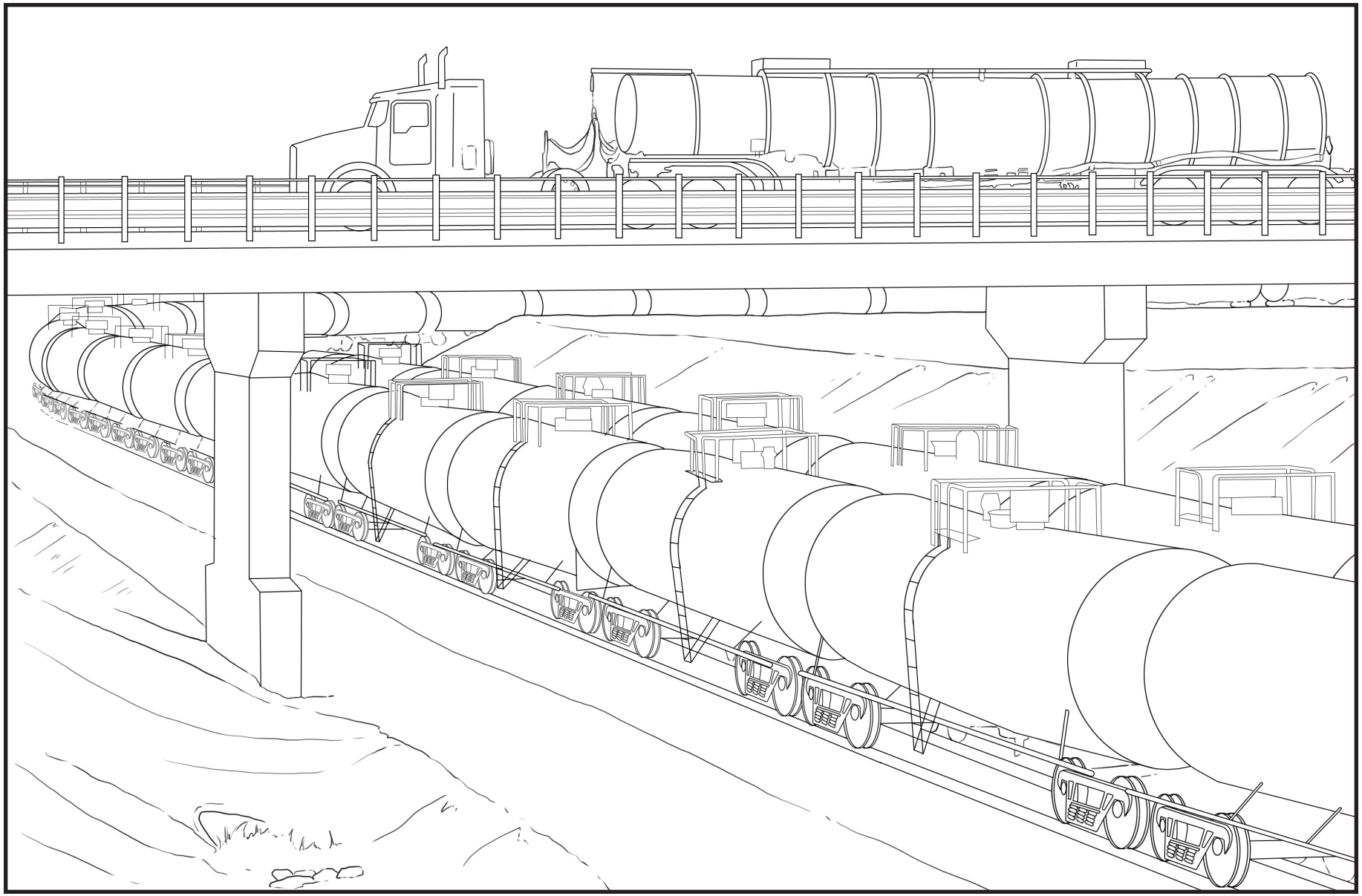




A byproduct of oil and natural gas production is saltwater. Remember, North Dakota was once a sea! North Dakota law requires that the saltwater be disposed of properly. Inspector John Bobrick visits a location called a saltwater disposal well to check meters and gauges to ensure the water is being disposed of properly. Saltwater travels to the disposal well two ways, either through an underground pipeline or via truck.

Connect the dots to reveal one way that saltwater is moved to the disposal well.

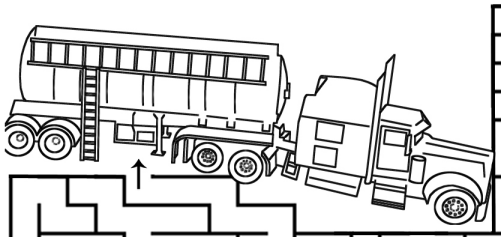




In order for oil to become products we use every day, it has to be safely delivered to the refinery where it can be processed. Oil is delivered three different ways: pipelines, trucks, and trains.

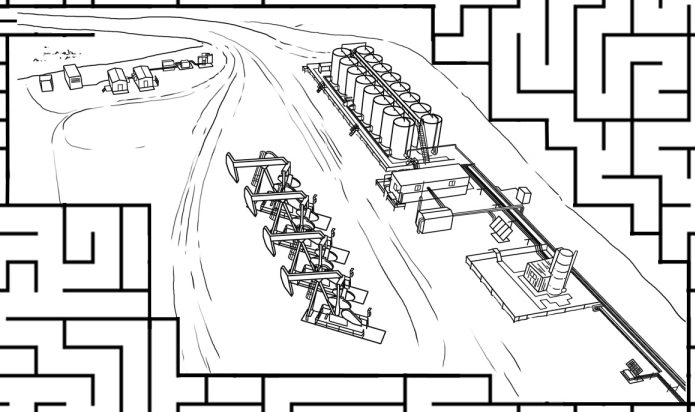
Find your way to the correct site! Follow a pipeline path to move oil to the truck, move produced water to the saltwater disposal site, and move solid waste to the landfill.

Oil Truck



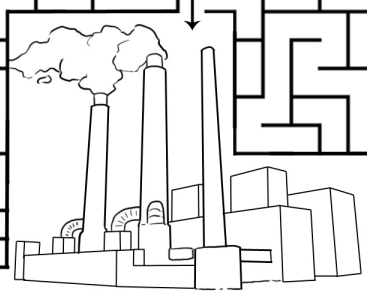
Saltwater Disposal Site



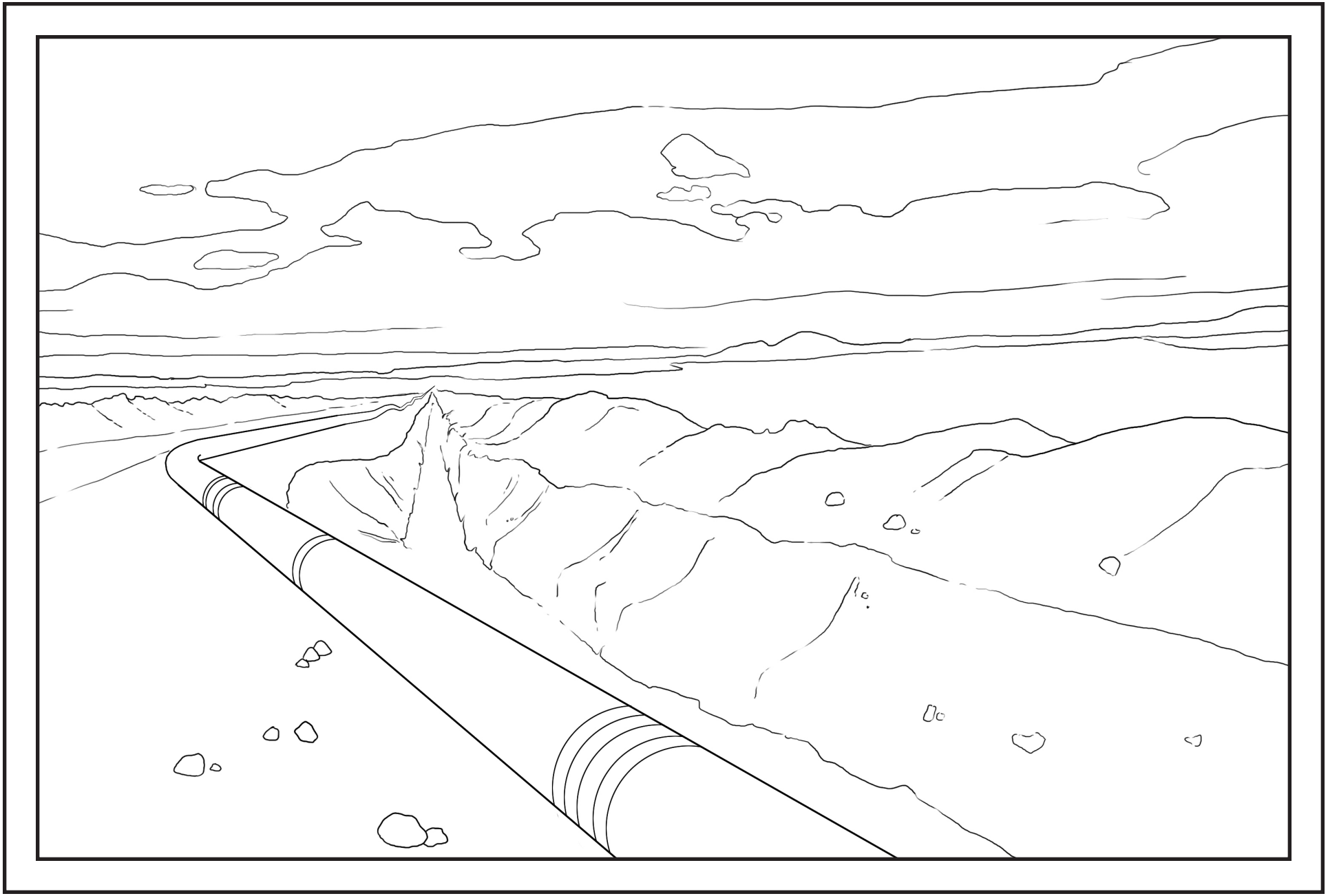




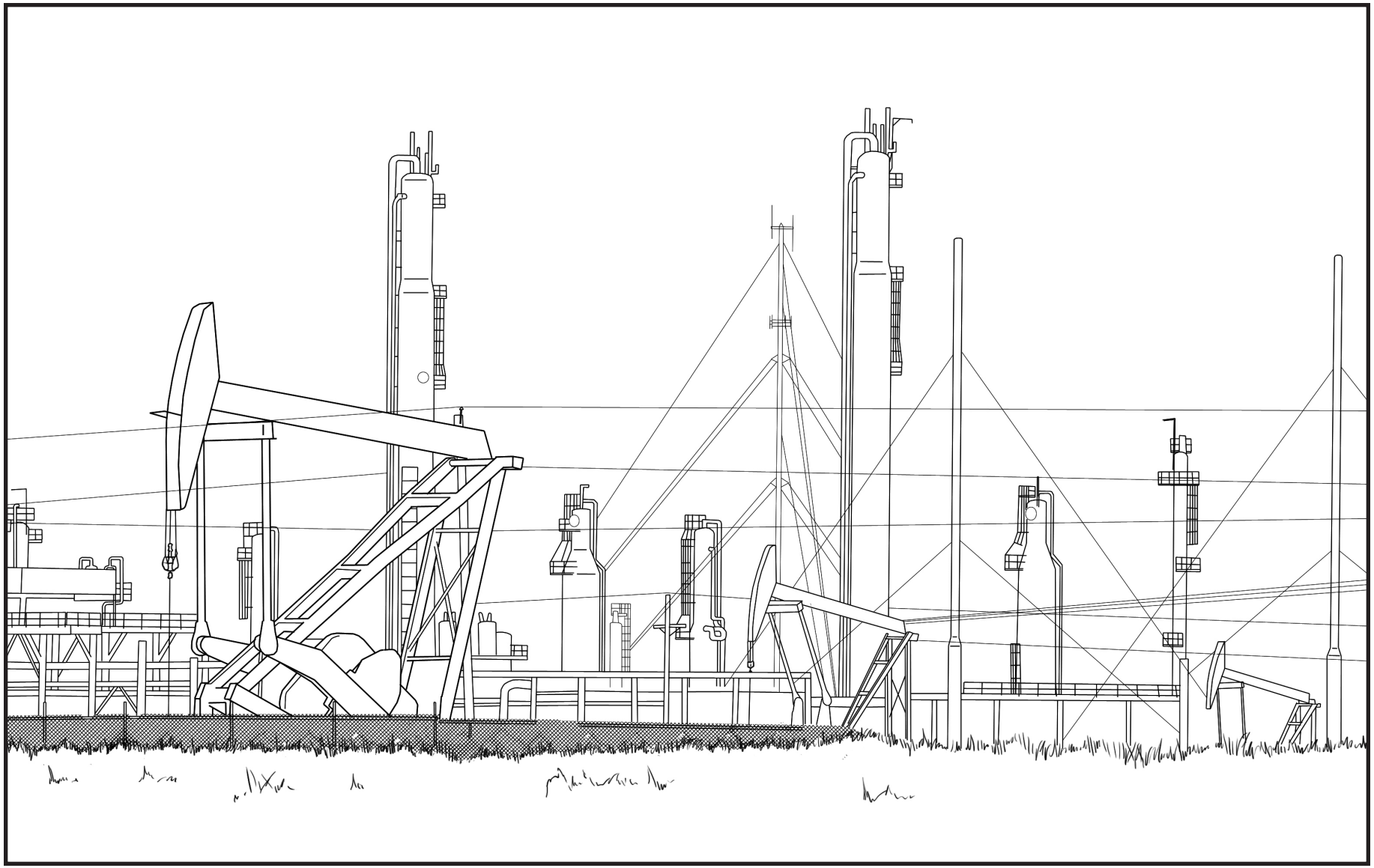
Landfill



Coal Plant

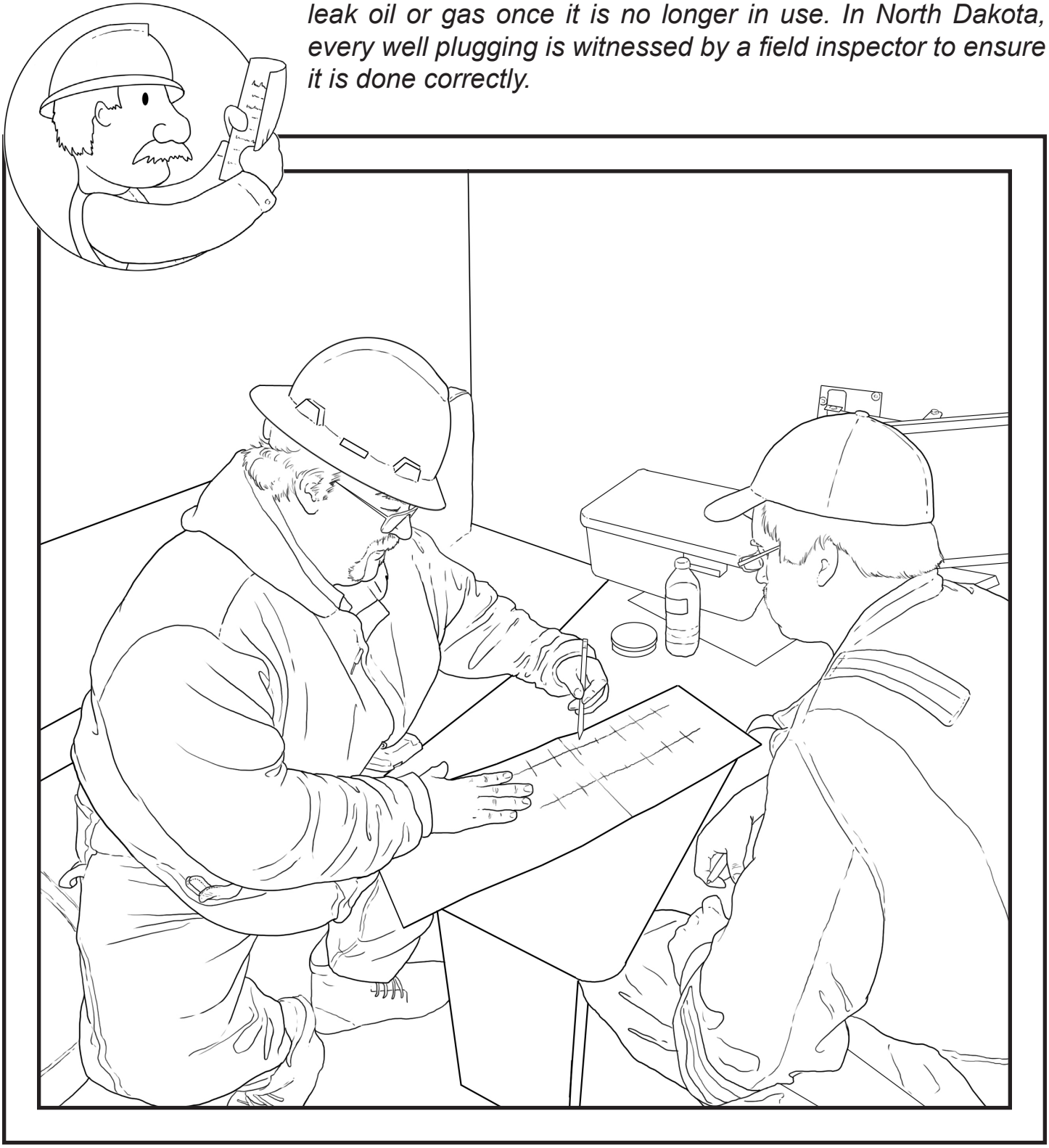


Unlike oil and water, the only way for natural gas to get to the gas plant is through an underground gathering pipeline. In this picture, a trench has been dug and a pipeline sits ready to be installed.

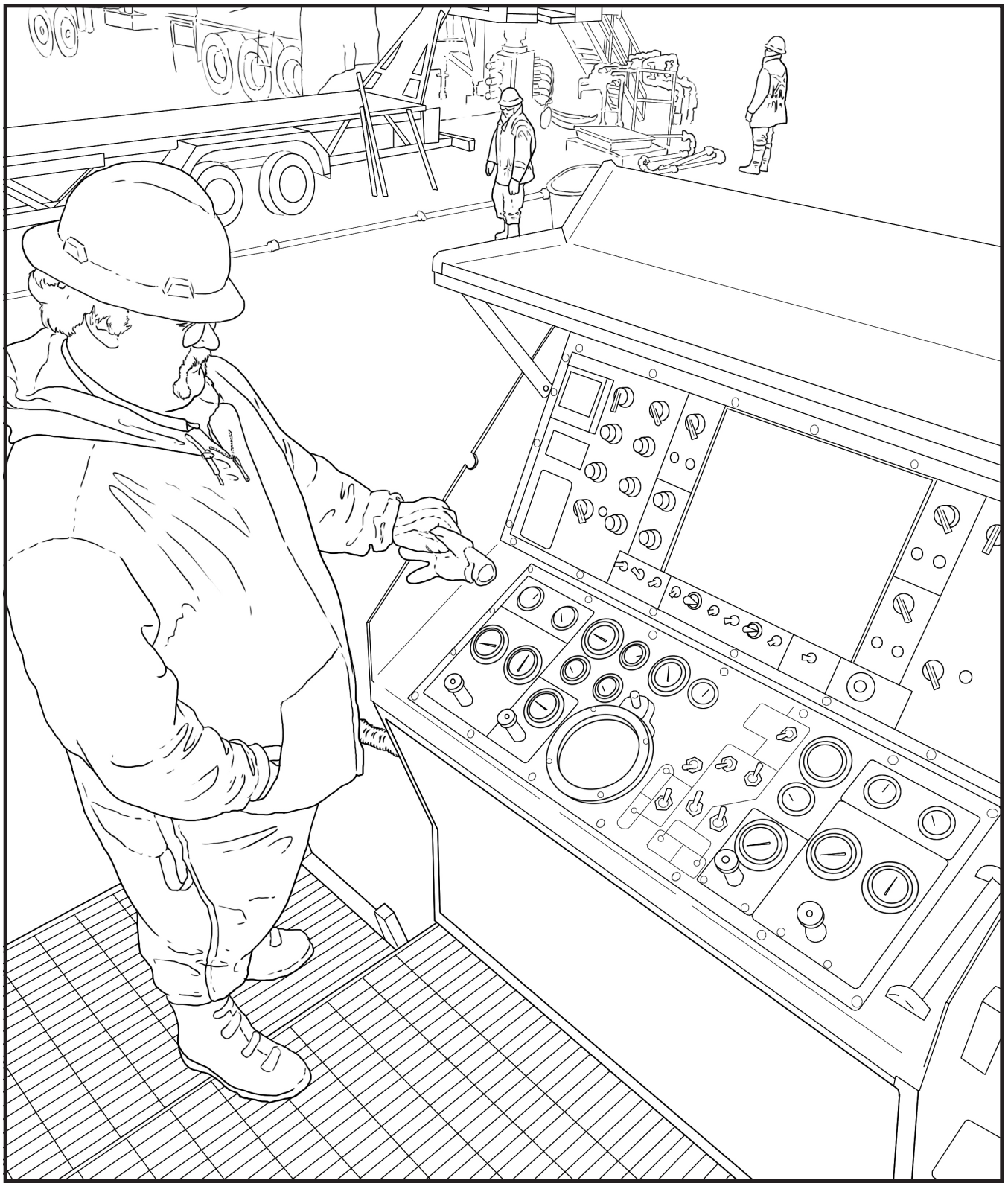


Pump jacks produce oil and natural gas just outside of the Hess gas plant in Tioga, North Dakota. Natural Gas gets collected by pipeline and sent to plants like this one to separate the materials in the gas for use. Once the gas is separated it can be turned into heat for our homes and components to make plastic products.

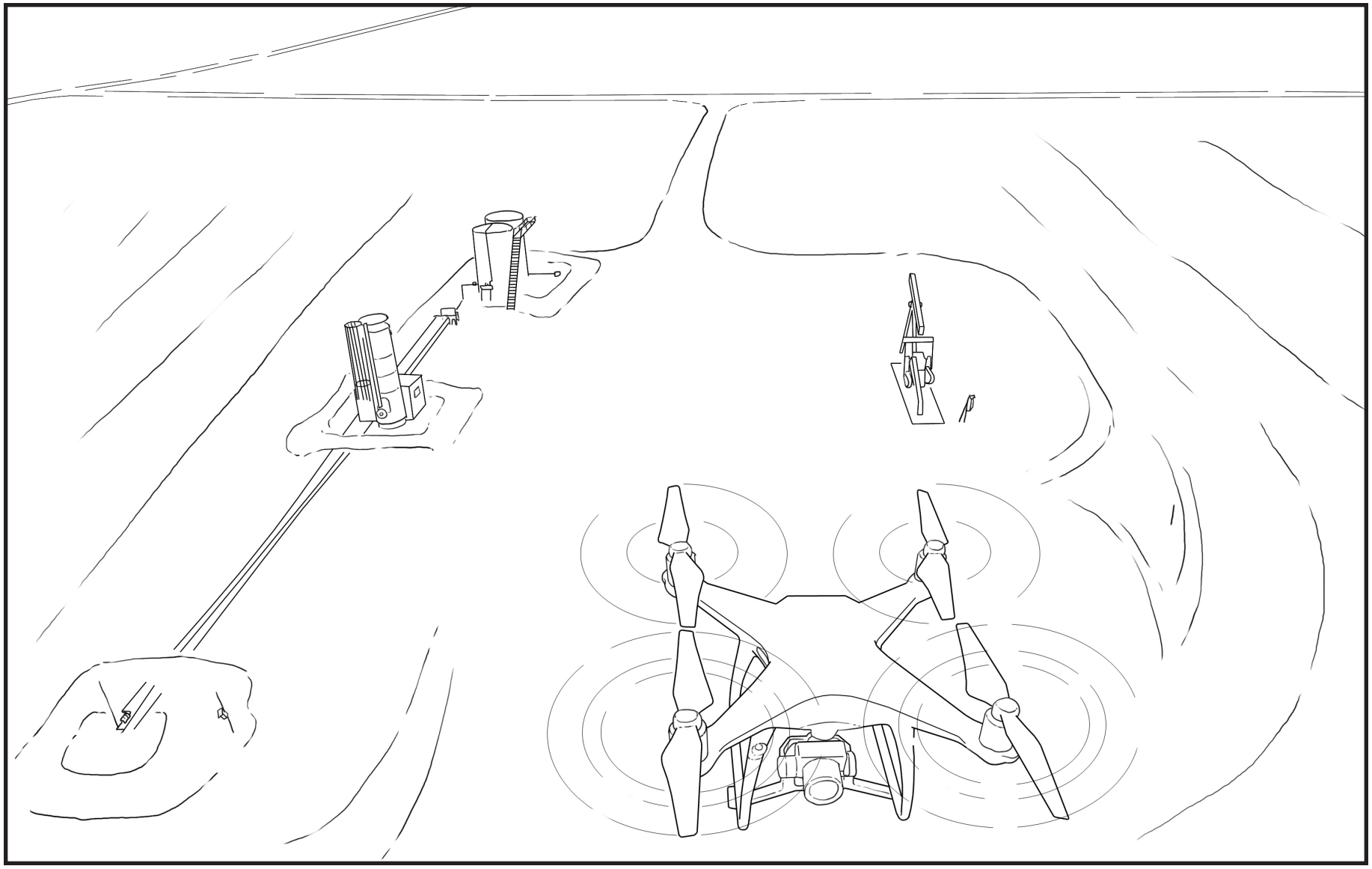
The field inspector will use a log to determine where cement plugs should be placed in the well so it will properly be plugged. Proper placement of cement plugs makes sure the well will not leak oil or gas once it is no longer in use. In North Dakota, every well plugging is witnessed by a field inspector to ensure it is done correctly.



When a well is no longer capable of producing oil and natural gas, the well needs to be safely plugged. An oil and gas field inspector goes over plans for plugging a well with a company representative.



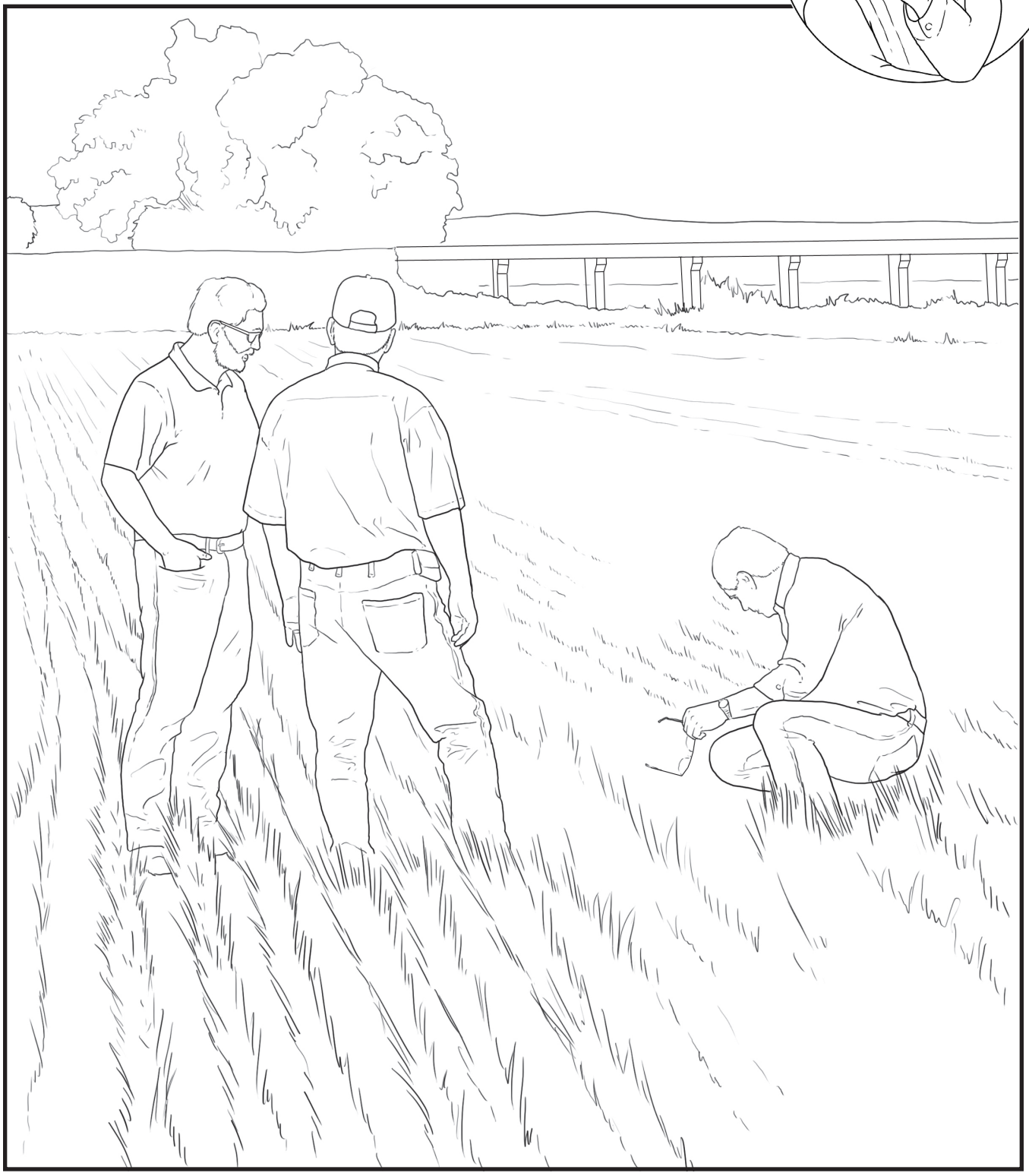
An oil and gas field inspector looks over controls that tell him what is going on down hole during a plugging operation. Once the well has been plugged, surface equipment will be removed and the company will begin the process of returning the land as close as possible to the original condition, through a process called reclamation.



The picture of this well site was taken with a drone. Inspector John Bobrick uses drones to get a better idea of what surface reclamation needs to be completed for a site. He also can use a drone to access a well site when the road has been reclaimed and can no longer be accessed with a pick-up truck.

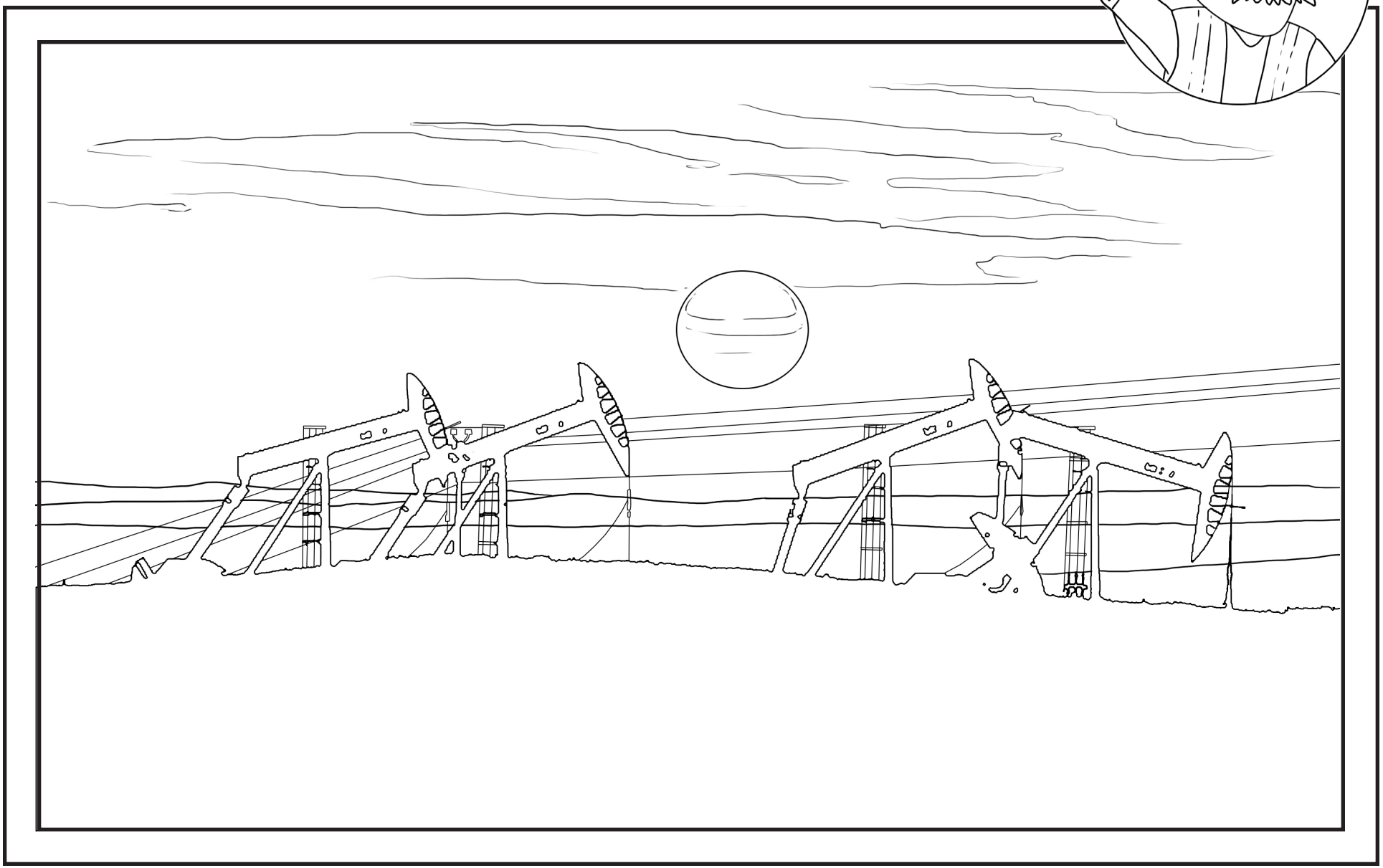
Here I am visiting with a landowner, the agriculture commissioner, and the oil and gas division director in a field that was once the location of a well site. This reclaimed site had scoria removed; top soil replaced and was re-seeded so the land can be used by the landowner once more.

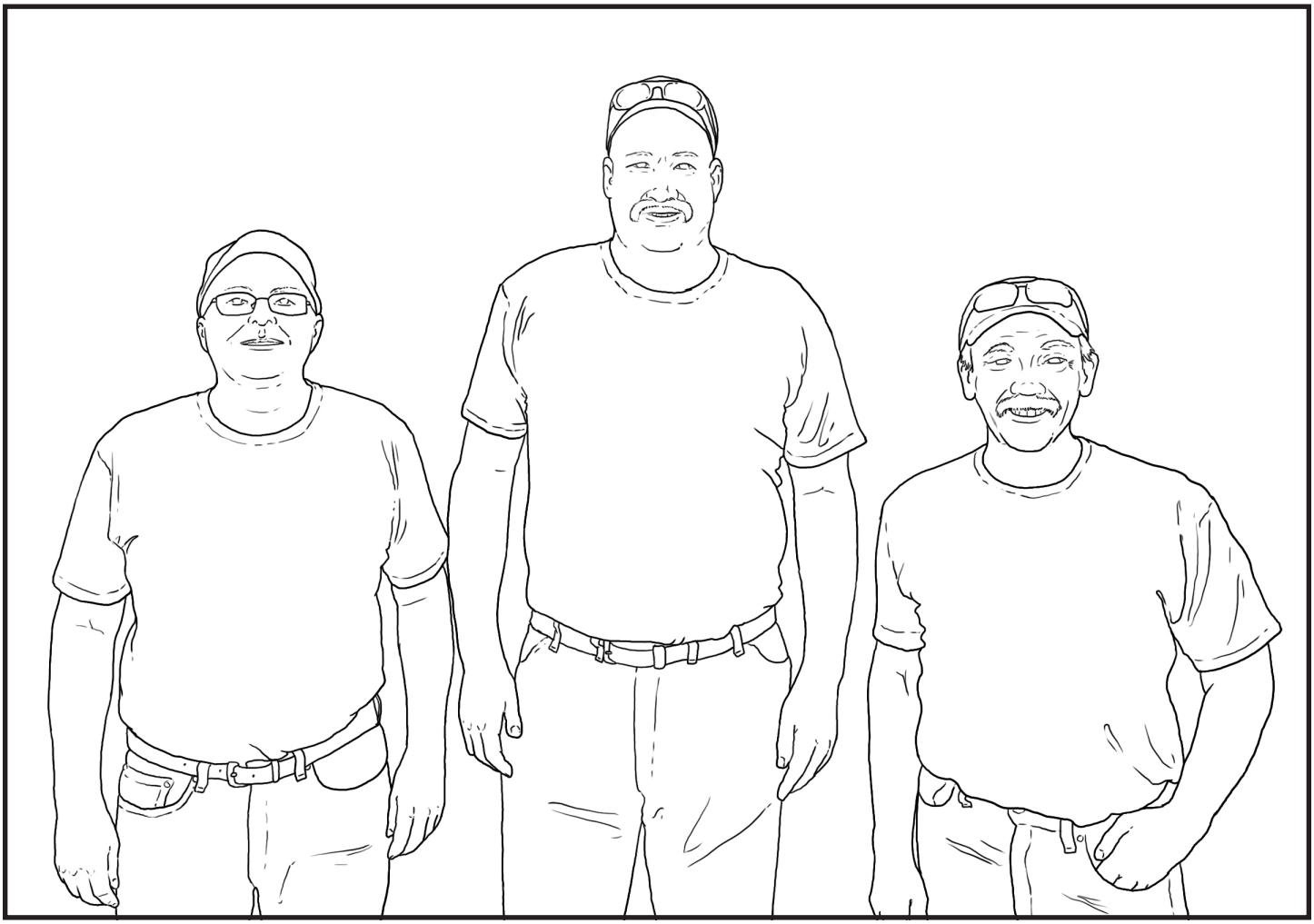




Oil and gas will be produced in North Dakota for many generations to come. The oil and gas division, through inspectors like me, makes sure this process is done safely and responsibly so all North Dakotans can realize the greatest possible good from our state's vital natural resources.







We want to take the time to thank the people behind the inspiration of the main character of this book, inspector John Bobrick. We are thankful for all the dedicated inspectors we have at the oil and gas division who work hard every day to make sure all stakeholders realize the greatest possible good from our state's vital natural resources. We want to thank our three district supervisors, John Axtman (L), Rick Hutchens (C), and Bob Garbe (R) for the tremendous leadership and commitment you have shown for more than 30 years each! Without you three, inspector John Bobrick would not have been possible! We also want to thank the following companies who provided photographs for this project: JMAC Resources, Inc.; Whiting Petroleum Corporation; Oasis Petroleum; Bilfinger Westcon, Inc.; ONEOK, Inc.; and Hess Corporation.

