Module 12: Optional Knowledge

Topic 1: Introduction

Module introduction

If you've gone through the other modules of this course, then you've covered your Fire Fighter Type 2 (FFT2) course materials in total—so, a hearty congrats is in order! We covered such basics as:

- **Terminology and procedures**
- **Information resources, such as the IRPG and Fireline Handbook**
- **Basics of working on a wildland fire** *incident*

The S-130 FFT2 represents the tip of the iceberg for professionals who might choose wildland fire fighting as a career. There's much more to know, and this module provides optional topics providing you with a taste of the wide variety of skills necessary to continue your advance into the wildland fire fighting field. Try going the extra mile—a small investment now often pays great rewards later.

Narration Script: If you've gone through the courseware in its entirety, you're well on your way to satisfying your coursework and moving toward the field performance testing. However, this module has some optional topics for you to check out. Like any endeavor, going the extra mile often pays big dividends in the end—so get set to cruise through this module.

Optional topics

This module takes you beyond the basics with these optional topics:

- **Using and maintaining portable water pumps**
- **Navigating with maps and compasses**
- **Investigating the** *origin* **of fires**
- **Protecting historic and cultural sites during wildland fire incidents**

Optional—yes. Important? Heck yes! The information in this module will make you a better informed and more versatile firefighter. Knowledge is power—both on the *fireline* **and in your career.**

Narration Script: The topics in this module aren't required, but they will still be very helpful for you in accomplishing your wildland fire fighting mission. We'll discuss pump operations, allowing you to get water from lakes, streams, rivers, or even backyard swimming pools. You'll find out about navigation tools, helping you get where you want to go even in completely unfamiliar places. You'll also see how the experts read a fire scene to determine the cause of the fire. This is important to you because you have a role in the fire investigation process as well. And finally, we'll show you how you can protect and preserve the artifacts of our nation's cultural resources—while you work.

Topic 2: Pump Operations

Pump operations introduction

The *portable fire pump* **may be your most practical** *wildland fire* **fighting technology.** *Apparatus* **can't be driven just anywhere, especially when you're off-road in rough terrain. Fire pumps can give firefighters easy access to remote water** *resources* **because a pump can be hand carried to lakes and streams. That is, the pump can tap the original** *fire suppression* **tool at its source—surface water.**

In this topic, we're going to pump up your knowledge in four key areas:

- **Pump types**
- **Pacific Mark 3 pumps**
- **Pump operation and maintenance**

It may not be the flash and glory of an *airdrop***, but knowing about pump engine operations and mechanics are part of what makes a wildland Firefighter Type 2 (FFT2) effective.**

Narration Script: Most people only associate heavy-duty fire engines with wildland fire fighting. They forget engines are limited in where they can be driven and natural lakes and rivers can provide an even greater supply of nature's own fire suppressant—water. Portable fire pumps will be one of your best friends in the wildland. They can supply pressurized water from any number of auxiliary water sources, and you can carry one by yourself or with the help of a fellow crew member. Natural water sources can be a gift to fire fighting or mop-up efforts, but only if you have and can properly use a well-maintained pump. Get ready. Let's get the blood and intellect pumping as we dive into pump types, delivery systems, operation, and maintenance.

Uses for portable fire pumps

Agencies use portable fire pumps for supplying water directly to the fireground from auxiliary water sources such as ponds, lakes, rivers, streams, and swimming pools. The water can be supplied directly to the fireground for fire suppression, *exposure* **protection, and to fill mobile water supply apparatus, such as** *water tenders***. And as we just said, portable fire pumps are used when the water-supply source is remote or inaccessible to fire apparatus.**

Narration Script: It's a relief when working a wildland fire to find a natural body of water to help out with fire suppression. But you have to get the water into your apparatus or hoses and onto the fire. That's when you call upon your knowledge of portable fire pumps.

Portable fire pumps introduction

Before you get to the pump setup and operation phase, there is some important background knowledge to tackle first:

- **Power heads (engines)**
- **Categories**

You will investigate each item in turn to fill up your knowledge reservoir.

Narration Script: There's a lot to learn about portable fire pumps, so take a deep breath, drink some coffee, and pump up your energy!

Portable fire pump engines

Portable fire pumps are powered by either a two-cycle or a four-cycle engine. Know the type of engine powering your pump so you can provide the right fuel and follow the proper maintenance procedures.

Two-cycle portable fire pump engines:

- **Run on a mixture of gasoline and oil**
- **Are similar to but more powerful than chain saw engines**

Four-cycle portable fire pump engines:

- **Run on gasoline**
- **Use a separate crankcase oil system for lubrication**
- **Are more powerful than two-cycle engines**
- **Are considerably heavier than two-cycle engines**

Land-based portable fire pump overview

Land-based pumps are one of the main categories of portable fire pumps. These pumps are:

- **Designed to be used either close to, or some distance from, the apparatus they are carried on**
- **Mounted in a cage or framework so one or more firefighters can carry them**
- **Set near the water's edge, with a hard-suction hose running from the pump to the water**

When fighting wildland fires, you may have to carry a pump, which is attached to a backpack frame, a long distance. Some pumps are split into two pieces: the pump motor and the pump itself. Each is carried in a separate backpack. Once you reach the point of operation, simply couple the two pieces together—according to the manufacturer's instructions—and you're good to go.

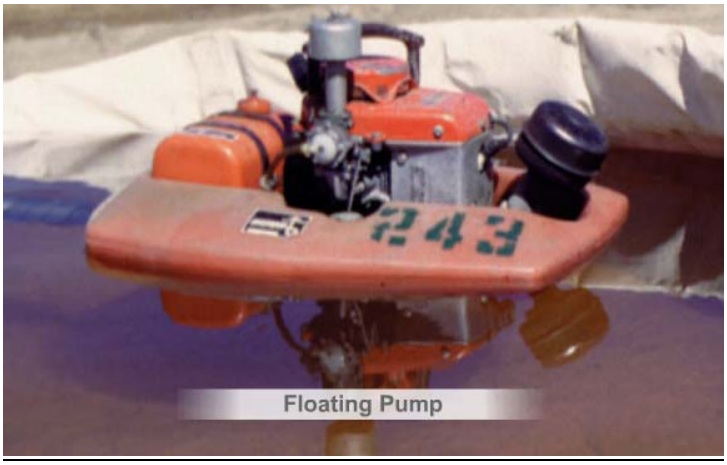
Narration Script: There are two broad categories of portable fire pumps—land-based pumps and floating pumps. We will get into floating pumps in the next section.

Floating portable fire pumps

Don't let terra firma stop you. *Floating water pumps* **are designed to operate from the water surface of the supply source. On floating pumps, the pump and pump motor are mounted on a large flotation device. The fire pump intake is connected to a strainer on the underside of the flotation device.**

Some floating pumps are able to operate in water as shallow as 6 in. (15 cm). It is sometimes necessary to tie or anchor floating pumps to prevent them from drifting or rolling over.

Narration Script: We promised to give you a chance to dive into the water, and here it is. Just don't forget to take your floating water pump along!



Caption: An example of a floating pump.

Knowledge Check 1

Multiple choice—check the box of the answer(s) you choose.

Portable fire pumps typically run on one of two engine types.

Identify TWO characteristics of the two-cycle engines used on portable fire pumps.

- ☐ **Run on a mixture of gasoline and oil**
- ☐ **Run on gasoline**
- ☐ **Are more powerful than the other kind of engine**
- ☐ **Use a separate crankcase oil system for lubrication**
- ☐ **Are similar to but more powerful than chain saw engines**
- ☐ **Are considerably heavier than the other kind of engine**

The correct answers are run on a mixture of gasoline and oil; and are similar to but more powerful than chain saw engines. The other items listed are characteristics of four-cycle engines.

Common land-based pumps

Now let's turn to land-based portable pump specifics. The most commonly used land-based pumps are:

- **Positive displacement pumps**
- **Centrifugal pumps**

You will examine each pump type in turn to flow through this discussion.

Narration Script: Are you ready for the low-down on land-based pumps? Two pumps commonly used for fire suppression in the wildland are the positive displacement pump and the centrifugal pump.

Rotary gear pump

You'll most likely find two common *positive displacement pumps* **on an** *incident***—the rotary gear pump and the piston pump. We'll talk about the rotary gear pump first.**

Rotary gear pumps are high-pressure, low-volume, positive-displacement pumps, and they are self-priming. These pumps are well suited for supplying small hose lines of considerable length or that are deployed uphill. Rotary gear pumps have a unique design:

- **Shafts**
- **Impellers**
- **Capacity**

Read the following to see the details of each design feature.

Shafts

Here are some points to keep in mind:

- **The pump contains two shafts with impellers attached, and the shafts are enclosed in an aluminum case.**
- **The shafts have gears on the case end.**
- **The lower shaft (drive shaft) is connected to the engine.**

Because of the close tolerances between the internal gears and the pump casing, these pumps wear out quickly if the water being pumped is not free of sand or other abrasives.

Impellers

- **Both the gears and the impellers have very close tolerances, allowing the pump to create a partial vacuum and vertically draft water 15 to 20 ft. (5 to 6 m).**
- **The partial vacuum and the pressure on the outside water source cause water to enter the case.**
- **The teeth of the impellers force the water around and out.**

Capacity

- **The system requires a pressure relief valve.**
- **The discharge capacity is directly proportional to the number of revolutions of the pump per minute.**

The water must be as clean as possible because any sand or dirt entering the chamber will damage the case and result in small passages that decrease the pump's airtight capacity.

Narration Script: Two positive displacement pumps you'll need to know about are the rotary gear pump and the piston pump. We'll examine the rotary gear pump first.

Caption: An example of a rotary gear pump.

Piston pumps

Piston pumps are positive displacement, self-priming pumps. They can be either single- or double-acting pumps that have a piston in each of one or two cylinders. Like rotary gear pumps, piston pumps deliver a relatively low volume of water at very high pressure. These pumps are usually bumper mounted or can be portable. Their operation is similar to other pumps.

Piston pumps work on the same principle as the two-cycle engine by:

- **Taking in and discharging water through the cylinder instead of a combustion mixture and expelling exhaust gases**
- **Drawing water into the cylinder as the piston starts its downward movement**
- **Discharging water as the piston starts its upward movement**

Caption: An example of a piston pump.

Centrifugal Pumps

Centrifugal pumps **function differently from positive displacement pumps in that they have to be primed before they will pump water. There are low- and high-pressure centrifugal pumps.**

- **Low-pressure centrifugal pumps—Once primed, they will deliver a high volume of water at relatively low pressure. Low-pressure centrifugal pumps are well suited for filling water tenders.**
- **High-pressure multi-stage centrifugal pumps—Many of these pumps will deliver a sufficient volume of water to supply one or more attack lines. Some of these pumps have thermoplastic pump cases and other components that keep their overall weight to less than 30 lb. (13 kg). Because of this, they are well suited as backpack units.**

Centrifugal pump functionality

Firefighters use the centrifugal pump more than any other in wildland fire suppression. Here's how a centrifugal pump works:

- **It contains one to four impellers.**
- **The impellers spin on a shaft, using gravity to force water from the center opening (suction) to the outside edge.**
- **Force is created as the impeller turns faster.**
- **Vanes inside the impellers control the water's motion and direction.**
- **Water thrown off the vanes is sent into an open cavity around the impeller.**
- **The water is sucked down into the center of the next impeller and out through its vanes.**

Narration Script: Like the rotary gear pump, the centrifugal pump uses impellers to pressurize water. The faster the impellers spin, the more force the water has.

Portable pumps—advantages and disadvantages

The type of pump your *crew* uses will depend on its reckoning of each pump's advantages and disadvantages. Knowing and understanding these factors will help you make the right, rather than the wrong, choice.

We've illustrated two commonly used pumps:

- **Positive displacement pumps**
- **Centrifugal pumps**

You will investigate each pump type in turn to get the facts on the advantages and disadvantages of each.

Narration Script: Each kind of land-based pump has its strengths and weaknesses. The pump you ultimately use will depend on how those factors align with the immediate water source and the incident. As you can see, making the right choice will require you to know as much as possible about positive displacement pumps and centrifugal pumps.

Positive displacement pumps—advantages and disadvantages

Advantages of the positive displacement pumps include:

- **Drafts water higher than a centrifugal pump—15 to 20 ft. (5 to 6 m)**
- **Produces higher pressures with less power**
- **Does not require priming unless the pump is worn**
- **Does not require a foot valve on the suction hose**

Disadvantages are:

- **Cannot be started with head pressure, i.e., from an uphill *hose lay***
- **Can be damaged by dirty water**
- **Requires a relief valve**
- **Changing fixed output and PSI is difficult**
- **Refill performance is low**
- **Difficult to maintain in the field**

Centrifugal pumps—advantages and disadvantages

Centrifugal pump advantages include:

- **Nozzle can be shut off for short periods while the pump is running**
- **Pressure can be changed by adjusting revolutions per minute (RPM)**
- **Relief valves are not required but are recommended**
- **Dirty water and small particles can be passed without damage**
- **Refill performance is good**
- **Maintenance cost is lower, and the pump can often be repaired in the field**
- **Head pressure can be used to start the pump**

Disadvantages of centrifugal pumps include:

- **Requires a foot valve with a suction strainer**
- **More power is required for higher pressures**
- **Priming is usually required**
- **Water cannot be drafted as high as with a positive displacement pump**
- **Bypass is required to avoid heating when no water is moved**

Knowledge Check 2

Matching—select the match you choose from the pull down list.

Positive displacement pumps and centrifugal pumps each have advantages and disadvantages.

Match each pump type to the appropriate advantage or disadvantage. You may use a type of pump more than once.

Centrifugal	Dirty water and small particles can be passed harmlessly
Centrifugal	Dirty water and small particles can be passed harmlessly
Centrifugal	Dirty water and small particles can be passed harmlessly
Positive displacement	Dirty water and small particles can be passed harmlessly
Positive displacement	Dirty water and small particles can be passed harmlessly
Positive displacement	Dirty water and small particles can be passed harmlessly

The correct matches are as follows:
Centrifugal: Has a lower maintenance cost and can be field repaired
Centrifugal: Dirty water and small particles can be passed harmlessly
Centrifugal: Priming is usually required
Positive displacement: Drafts water the highest
Positive displacement: Cannot be started with head pressure
Positive displacement: Higher pressures are possible using less power

Specific delivery systems

So far, we've painted the big pump picture—that is, talking about two main types of pumps you'll use in the field—positive displacement and centrifugal pumps. Now it's time to name names.

We're going to examine two delivery systems:

- **Pacific Mark 3 Centrifugal Pump**
- **Wajax-Pacific/Halprin™ Wildfire Mark 3 Pump**

Narration Script: You know pumps are not just a collection of randomly welded mechanical parts. Like automobiles, pumps have a specific design, or system, intended to make them operate at maximum capacity. Chances are you'll encounter a few commonly used pumps when working

an incident. Of course, technology and preferences will vary from agency to agency, but we'll give you the basics of two commonly encountered pumps.

Pacific Mark 3 centrifugal pump

Here are the Pacific Mark 3 centrifugal pump's central features.

Design:

- **Two-cycle, air-cooled engine**
- **Four-stage centrifugal pump**
- **Uses mixed gas 1/2 pint per gallon with a 16:1 ratio (unless manufacturer guidelines specify otherwise)**
- **Weight—55 lb. (25 kg)**
- **8.5 horse power (hp)**

Maintenance:

- **Fuel consumption is approximately 1.2 gal. (4.5 l) per hour**
- **Lubricate pump after 30 hours of use**

Wajax-Pacific/Halprin Wildfire Mark 3 Pump

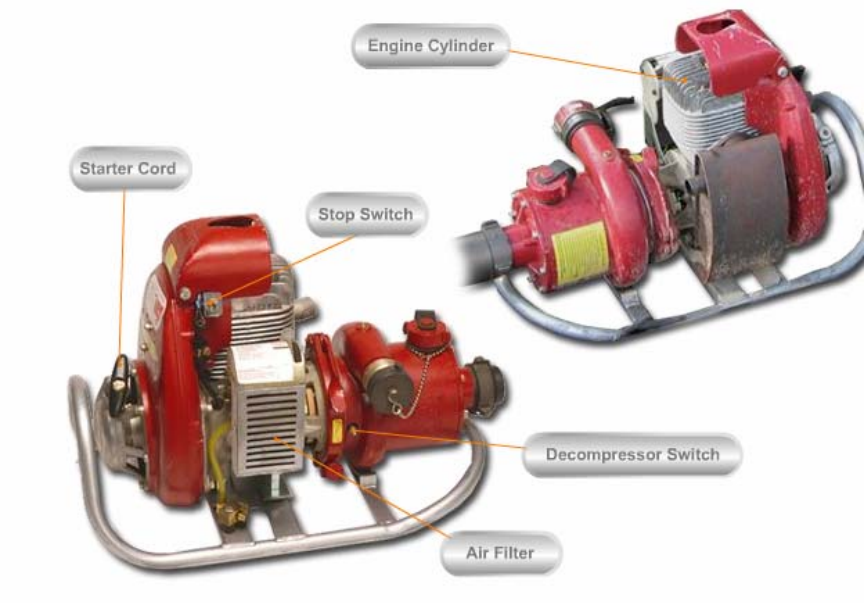
The Wajax-Pacific/Halprin Wildfire Mark 3—also called simply the "Mark 3"—is coupled with a four-stage centrifugal pump. The Mark 3 is an efficient unit designed to meet the requirements of all fire control techniques. The Mark 3's wide performance range makes the pump useful for both filling tanks and suppressing wildland fires. It's also suitable for rural and municipal fire protection or wherever a large volume of water is needed.

Read the following to learn more about each part of the Mark 3:

- **Engine cylinder—This pump has a two-cycle, single cylinder, 8.5 hp, rotex air-cooled engine.**
- **Fuel—Fuel must be mixed with oil. The fuel tank holds 5 gal. (19 l) of mixed fuel and attaches to the pump engine using a quick connect fitting.**
- **Starter cord—The starter cord and handle is a spring-loaded rewind unit. If a rewind failure occurs, start the engine by putting the rope on the crankshaft pulley.**
- **Decompressor switch—Some Mark 3's feature a decompressor switch that releases pressure from the combustion chamber, easing engine startup. Close this switch as soon as the engine starts to prevent damage to the engine.**
- **Stop switch—Use the stop switch to shut off the engine after a cool-down period or in an emergency. Hold the switch down until the engine has completely stopped.**
- **Air filter—The air filter is located inside the metal shroud connecting to the carburetor.**
- **Choke lever—The flip-like choke lever closes the butterfly in the carburetor for a richer fuel mixture when starting a cold engine.**

Narration Script: The Wajax-Pacific/Halprin Wildfire Mark 3 Pump delivery system is commonly called the Mark 3 pump. It's designed to meet the requirements of all your fire

control techniques. We have a lot to tell you about this system. If you're into engine design, you'll enjoy this discussion.



Caption: A Wajax-Pacific/Halprin Wildfire Mark 3 Pump.

Additional Mark 3 pump features

Hang on; we have a few more Mark 3 design features to go.

When operating the Mark 3, understand these safety features:

- **Set the throttle control according to the directions on the label found on the control itself**
- **The automatic cut-off switch stops the engine and eliminates over-speeding when the pump runs out of water or loses prime**
- **The reset rod on the automatic cut-off switch may not work if the throttle is set halfway—the engine RPM may not be high enough to trip the reset**

Pacific Mark 3 supplemental information

Before we move on to the pump operator's role, we're going to quickly run you through a few supplemental Mark 3 details:

- **Starter**
- **Muffler**
- **Automatic cut-off**
- **Shut-off conditions**
- **Ignition checks**

Read the following to get the quick run-through about each detail.

Starter

- **The starter is mounted on the end of the pump.**
- **It consists of the cord and handle, spring and clutch, and the housing.**
- **When starting the pump, do not extend the starter cord to full length or allow it to snap back to the returned position.**

Muffler

- **The muffler is located on the right side of the pump when viewed from the pump end.**
- **It muffles the noise and serves as a spark arrestor.**

Automatic Cut-off

The Mark 3 features an automatic cut-off switch stopping the engine and preventing damage if over-speeding occurs.

- **Do not for any reason bypass the automatic cut-off switch**
- **Do not attempt to restart the engine until the problem has been located and corrected**

Shut-Off Conditions

The unit will shut down whenever the:

- **Pump is not fully primed**
- **Suction hose connections are leaking**
- **Suction hose is defective**
- **Cap on primer opening is loose**
- **Foot valve is leaking or not completely submerged**
- **Suction hose has an air lock**

Ignition Checks

To check the ignition spark:

- **Remove the plug from the engine or use a spare plug**
- **Attach the spark plug to the plug wire**
- **Ground the plug body to the cylinder head**
- **Crank the engine—a spark across the normal spark plug gap will not damage the coil**

Do not remove the spark plug wire while cranking or running the engine—doing so may increase the electrical load in the coil enough to short out the windings.

Narration Script: We're going to throw just a few more Mark 3 pump details at you. This is supplemental information, but it's important, too. The more you know about this delivery system, the better. Here we discussed the Mark 3's starter and muffler, motor protection, and ignition checks.

Knowledge Check 3

Multiple choice—check the box of the answer(s) you choose.

The Pacific Mark 3 centrifugal pump is a type of portable pump delivery system. Identify the set of values BEST completing the following sentence.

The Pacific Mark 3 Centrifugal Pump weighs _____ lb. and has _____ hp.

- ☐ **85, 7.5**
- ☐ **75, 6.5**
- ☐ **65, 9.5**
- ☐ **55, 8.5**

The correct answer is 55 and 8.5.

Pump operator

You now know the types of portable fire pumps available to you, so let's consider the role of the pump operator. The pump operator runs the water delivery operation by using pump components, properly setting up the pump, and maintaining a consistent water supply. In fact, maintaining an uninterrupted and pressurized supply of water to the nozzle operator is the pump operator's most important task. If a pump doesn't work properly, the chances of successfully fighting the wildfire could be threatened.

Here are a few important aspects of the pump operator's role:

- **Safety**
- **Pump kit components**
- **Pump site location and pump setup**

We'll examine each of these areas in turn.

Narration Script: Now that we've finished our discussion of pump types and mechanics, let's get back to the firefighter—you. At some point you may have to serve as the pump operator. That's the person who sets up, runs, and maintains the pump. It's an important job. The pump operator is responsible for making sure the crew is able to use its most vital resource—water—and for ensuring a constant, pressurized water supply is maintained without interruption. Are you up to the job? Once you've finished this discussion, you will be.

Safety

In your role as pump operator, safety will be a priority. Consider these safety guidelines.

Clothing:

- **Have a warm coat available**
- **Do not wear loose clothing**
- **Wear a hard hat and gloves**

- **Wear ear plugs and further protect your ears by standing away from the pump when possible**

Equipment:
- **Watch your step around the pump and fuel line being mindful of slippery ground**
- **Watch out for the hot manifold and exhaust**
- **Rig any needed night lighting early in the day**
- **Store extra gas and equipment in a safe area**

The bottom line is to prepare ahead of time—anticipate what you are going to need in advance. And don't forget this all-important pump operator safety guideline—never, ever go to sleep on the fireline or when operating the equipment.

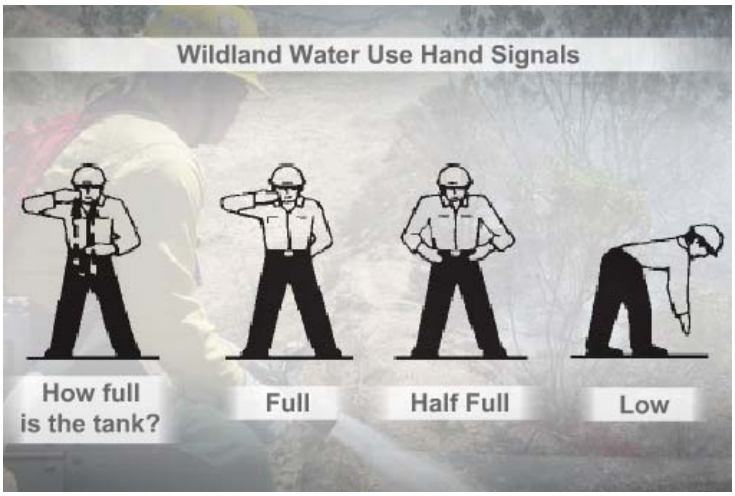
Narration Script: As always, safety is one of the pump operator's priorities, especially when it comes to clothing and equipment. Make sure you have a warm coat, hard hat, gloves, and ear plugs—those portable pumps can get pretty loud. Also, be careful not to trip or burn yourself on the engine, slip on wet ground, or inhale the exhaust. Prepare your equipment and your night lighting early, and always store extra gas and equipment in a safe area. Oh, and there's just one more thing. No matter how tired you may get on the job, don't ever fall asleep while you're the pump operator.

Communications

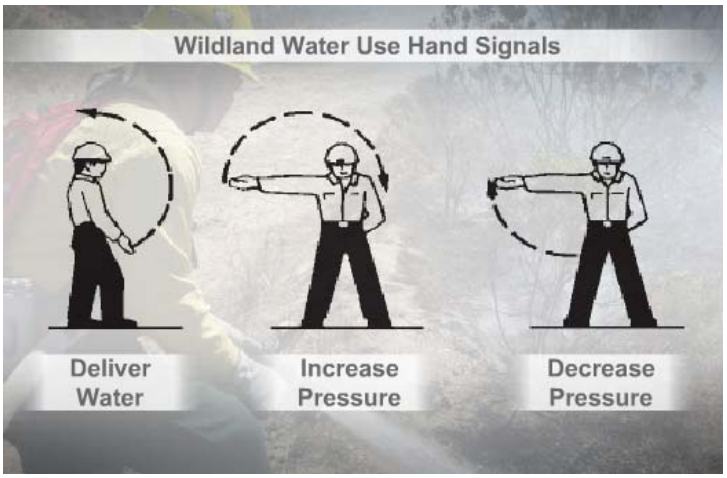
The pump operator must also keep radio contact with the rest of the crew and with the nozzle operators. Communication is critical to safety.

If you cannot maintain radio communication with the nozzle operators, use hand signals:
- **Four hand signals indicate how much water is in a tank.**
- **Three signals tell the pump operator to start the water flowing to the nozzle, or to change the water pressure.**
- **Three signals indicate more hose is needed, the hose is broken, or the hose can be rolled up.**
- **One signal indicates the operation can be shut down.**

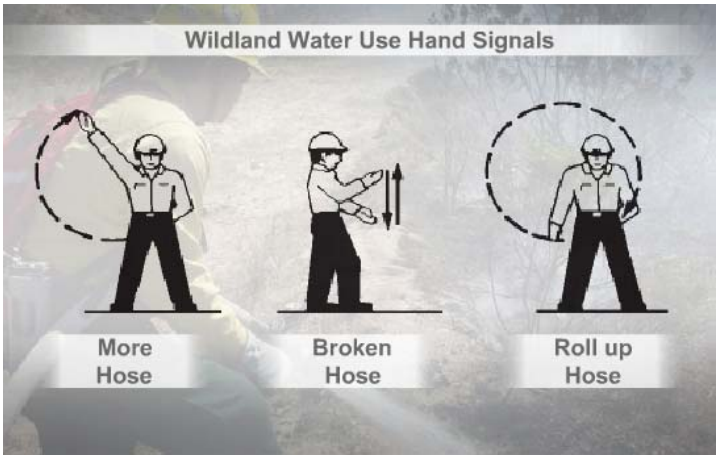
Narration Script: Communication with the crew and nozzle operators is critical for the pump operator. You should always have a radio to keep in contact with the rest of the crew. If radio communication with the nozzle operators isn't possible, use these hand signals. You can refer to these hand signals by looking in your IRPG under the Wildland Water Use Hand Signals page in the white section. The IRPG is available in the resources accompanying this course.



Caption: The signals used for identifying how full a tank is.



Caption: The hand signals used for water delivery or water pressure changes.



Caption: The hand signals indicating more hose is needed, a broken hose, or to roll up a hose.

Caption: The hand signal for shutting down a water delivery operation.

Pump kit

As the pump operator, you will also be responsible for ensuring the necessary equipment is on hand during pump setup. In addition to the pump itself, consider these supplies as your basic pump kit:

- **Fuel can with the appropriate fuel or mixture of fuel and oil**
- **Fuel supply line (with compatible hose and connections on can and pump) for pumps capable of being supplied directly from a fuel can**
- **Tool roll containing pliers, wrenches, a rubber mallet, and other small tools you may need to operate the pump**
- **Spare gaskets for any pump connections requiring them**
- **Suction hose with strainer or foot valve**
- **Supply and attack hoses to connect to the pump**
- **Nozzles and fittings**

Narration Script: If you are the pump operator, you will shoulder the responsibility for making sure all pump-related supplies reach the pump site. These supplies make up your pump kit, and they will help you guard against potential pump failure and malfunctions.

Portable fire pump setup

The pump operator has to know better than anyone else how to set the pump up. To set up a portable fire pump, follow these steps:

1—Choose an appropriate location
2—Place the pump on a solid base
3—Connect the hoses and prepare the pump
4—Start the engine
5—Listen to the engine

Read the following to learn more about each step.

Choose Appropriate Location

The first, and perhaps most important, step in setting up a portable fire pump is choosing a good operating location. Choose a location with a water source:

- **Of sufficient depth and volume to supply the pump for the assigned task**
- **Relatively free of dirt and debris so the pump will not become clogged during operation**

Place on Solid Base

The second step is to place land-based pumps on a relatively flat, solid base as close to the water level as possible. While most portable pumps are capable of drafting from heights of 10 to 12 ft. (3 m to 4 m), their pumping capacity decreases proportionately with an increase in lift. The ideal height is no more than 2 to 3 ft. (0.6 to 0.9 m) above the water's surface. If the pump must be placed on a slope, tie it down.

Connect Hoses and Prepare Pump

Third, connect the suction and discharge hoses. Also complete other preparations, such as filling the fuel tank, at this time.

Start Engine

Fourth, start the pump engine and operate it according to the manufacturer's instructions. Most engines are started manually using a recoil-type, pull-cord starter. Some engines may require a choke, depending on engine design.

Listen to Engine

Listen to the sound of the pump. The pump's tone will change with the opening and closing of the nozzles up the hose line. As nozzle operators open their nozzles, the tone deepens. As they close their nozzles, it will have a higher pitch. This should tell you the pump is working as it should.

Narration Script: You've chosen the pump you want to use for a particular incident, and now you need to get that puppy set up. The first step is location, location, location. Next, create a solid foundation. Then connect the hoses and prepare the pump. Now, ladies and gentlemen, start your engines!

Portable fire pump setup considerations

When setting up a portable fire pump, keep in mind two other considerations:

- **Environmental impact—Catch and absorb any fuel leaks or spills by placing a containment basin and absorbent pad beneath land-based pumps.**
- **High-water tables—If the pump starts sinking, the mud may get into the flywheel housing or deposit on the engine cooling fins, causing the unit to overheat. The mud can also enter the starter cord housing and affect the recoil on future startup attempts.**

Keep this from happening by resting it on a small platform made out of logs or similar material.

Narration Script: You may run into a couple of problems when using portable fire pumps in the wildland. You are using these pumps in or near water, so you have to be careful of environmental contamination. If you have a leaky fuel system or if you're not careful when you fill the fuel tank, the fuel may spill into the water or the soil beneath the pump. Take steps to avoid that and be a preserver of ecologically sensitive areas.

Another common problem is setting up a pump in an area with a high water table. In this case, the pump vibration can cause water to rise to the surface of the ground, and the pump can slowly sink into the mud. This can create a muddy mess; one you can avoid by taking some simple precautions.

Portable fire pump care and maintenance

Maintaining your portable fire pumps is just as important as maintaining all of your other equipment.

The main concerns regarding portable fire pump care and maintenance are:

- **Making any repairs necessary while operating in the field**
- **Conducting routine cleaning and maintenance in the station following every use of the pump**
- **Pump head maintenance should not be done on the fireline**

All care and maintenance must be done according to the pump manufacturer's instructions. A pump mechanic should perform any other significant repairs or servicing.

Narration Script: You break it, you buy it, right? Well, not quite. While you might not know how to maintain portable fire pumps, you better find someone who can. Routine maintenance is in keeping with the time tested cliché, "An ounce of prevention is worth a pound of cure." And be sure to do your pump maintenance immediately after you are done with it so there will be no surprises when someone tries to use it on the next fire!

Storage

Pump storage is the final thing you need to know about before we move on to our next subject: pump configuration. Proper storage helps keep a pump in good working condition.

If the pump is being removed from the incident or will be out of service for some time, follow these steps:
1—Push the throttle control lever to the "Stop" position. Let the engine idle for one minute.
2—Disconnect the fuel line from the fuel tank, ensuring an adequate cooling-down time. The fuel line will be empty at this time.
3—Disconnect the fuel line from the engine fuel connect.

4—Work the choke lever back and forth when the engine begins to sputter, eliminating all gas in the carburetor. This will prevent varnish buildup (residue from old gas left in a carburetor over a long period).

Narration Script: Okay. You know the difference between some important pump types, and you know how pumps are designed. You understand the pump operator's role, how to locate a suitable pump site, and how to set up and maintain a pump. Before we move on to pump configurations, there is one last thing you need to learn—how to store a pump.

Pump operations summary

In this topic, we've pumped you full of portable fire pump information. It's a good thing, too, because there will be times when you won't have engine support on the fireline. When duty calls, you'll now be familiar with pump design options, setup, maintenance, and multi-pump configurations.

Specifically, we've looked at:

- **Pump types**
- **Pump delivery systems**
- **Mark 3 pumps**
- **Pump operations and maintenance**

Stay tuned for the next topic, where you'll learn about the fine art of wildland navigation.

Narration Script: An abundant source of open water is always a welcome sight during a wildland incident. Reservoirs, lakes, rivers, and streams can provide your crew with an uninterrupted water supply, not to mention a safety zone should you need one. Of course, the water is a gift only if your pump is in good operating condition and someone knows how to use it. Without that knowledge, you might as well be floating down a river without a paddle.

In this topic, you also learned about pump operations and maintenance. This information is as important as any you will carry away from your fire fighting training.

Topic 3: Navigation

Navigation introduction

Navigating your way to a remote *fire*—**or reporting the location to** *command*—**can be a challenging part of your job. Getting the job done requires navigating accurately using a map and compass.**

In this topic, you'll learn:

- **How to use maps for** *pre-incident planning*
- **Types of maps used for fire fighting**
- **Basic map reading skills**
- **Navigating with a map and compass**

Narration Script: Wildland fires are called "wildland" for a good reason. They frequently occur far from accessible roads or trails. That's why map reading and navigation are integral elements of wildland fire fighting.

Your ability to interpret maps is an instrumental skill for incident pre-planning. You can use maps and your familiarity with your response area to identify available resources like staging areas, access routes, and natural water supplies, and your map reading skills allow you to correctly report the location of a fire. Your ability to use navigation tools makes it possible for you to reach fire sites that are inaccessible by road or trail.

Maps, local knowledge, and pre-designated components

Successful *wildland fire* **fighting requires a thorough familiarity with the fire site and the surrounding area. You need to know how to get where you're going, what you'll find there, and how you can make use of local** *resources***. In other words:**

- **Maps**
- **Documented local knowledge**
- **Pre-designated components**

Unlike some of the other elements of pre-planning—which tend to be the responsibilities of officers—these are directly of interest to firefighters at every level.

Map types

A map is a graphic representation of the earth's surface as seen from above. Accurate and easy-to-read maps are critical for all aspects of wildland fire fighting, from pre-incident planning to *incident* **response. Maps come from many sources:**

- **Chambers of commerce**
- **City and county offices**
- **Highway departments**
- **Other government agencies**

- **Automobile clubs**
- **Commercial map publishers**

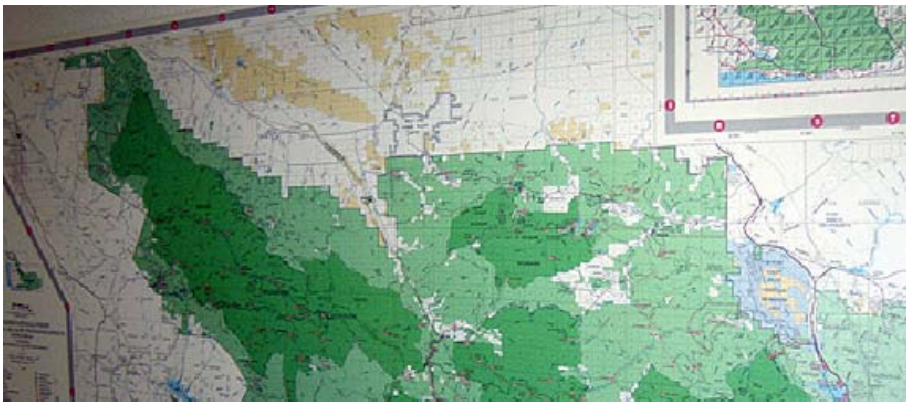
Many different types of maps are available. It is often useful to have different types of maps of the same area. Some of the most common types of maps include:

- **General plot (planometric) maps**
- **Topographic maps**
- **Special maps and aerial photographs**
- **Rural addressing maps**
- **Orthophoto maps**

Read the following for more information on each map type.

General Plot (Planometric) Maps

General plot (planometric) maps show jurisdiction boundaries, distances, roads, communities, and similar features. These are similar to *land survey* maps (which we will cover later) because they show the same kind of features. However, land survey maps are divided into sections, townships, and ranges for conveniently and consistently describing the location of a fire.



Caption: An example of a general plot (planometric) map.

Topographic Maps

Topographic maps show natural features, such as:

- **Rivers**
- **Streams**
- **Hills**
- **Valleys**
- **Open areas**
- **Lakes**
- **Elevations**
- **Ponds**

Topographic maps are available from the U. S. Geological Survey (USGS) on its Web site: *http://www.usgs.gov*. They're also available on CD-ROM from local sporting goods stores. You'll learn more about topo maps later in this topic.

Caption: An example of a topographic map.

Special Maps and Aerial Photographs

Special maps and aerial photographs show locations of:

- **Permanent structures and developed campsites**
- **Railroad beds**
- **Electrical power lines**
- **Transmission piping for gas, water, sewer and petroleum products**


Caption: An example of an aerial map.

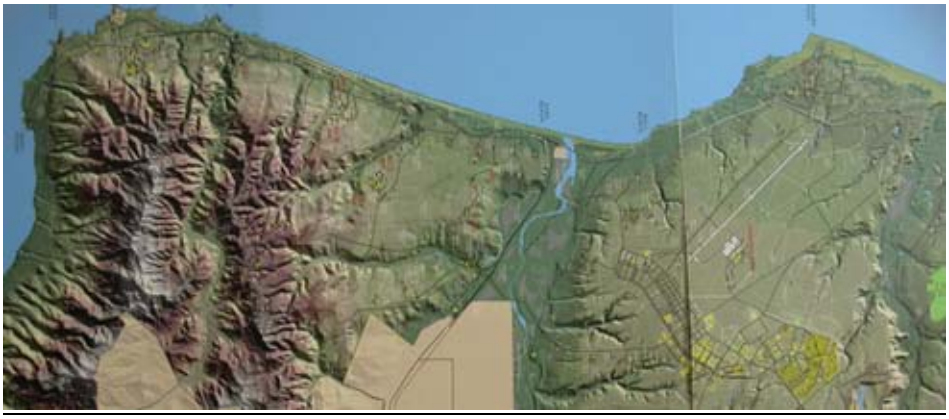
Rural Addressing Maps

Rural addressing maps assign and number residences by the distances in hundredths of a mile from the start of the road. These maps are often developed by local utility and service companies.

Caption: An example of a rural addressing map.

Orthophoto Maps

Orthophoto maps are aerial photographs corrected to scale so that geographic measurements may be taken directly from the prints.



Caption: An example of an orthophoto map.

Narration Script: It's frustrating when you can't find your way to a fire scene. If you've ever worked from an out-of-date map book or received incomplete address information from dispatch, you know the feeling. Maps of all kinds help you respond quickly and let you know what you can expect to find when you get there. There are several map types available to you.

More map types

There are still more types of maps you may come across. You may already be familiar with some of these:

- **Highway maps—these familiar maps used by automobile travelers indicate towns, highway route numbers, and distances between them. These maps rarely include additional detailed features.**
- **Aeronautical charts—designed for pilots, your dispatch office may keep these for airspace management at fire scenes.**
- **Military maps—are detailed maps with information useful to military personnel. They may lack information needed by fire fighting agencies.**

- **Local maps such as Geographical Information System (GIS) maps—include a variety of maps produced for the specific needs of their users, such as maps showing fire perimeters, cultural resources, and other areas of concern.**

Narration Script: Maps of all types are useful to firefighters to determine appropriate fire fighting tactics. For example, on multi-day fires and with the right GIS specialists, they can produce maps showing how fire may spread relative to weather and topography factors. Even on initial attacks, dispatchers may have access to GIS maps and can communicate any special concerns to wildland crews.

Documented area knowledge

First-hand knowledge of a response area adds a valuable dimension to your planning. Your maps will make more sense when you can visualize the terrain. When you survey the area in person, you can talk to local residents, drive the roads, and walk the trails.

Observe and make notes about:

- **Type, condition, and concentration of vegetation**
- **Terrain and landmarks**
- **Trails and access roads**
- **Streams and other water supplies**
- **Structures and other values at risk**
- **Locations and weight limits of all bridges within the district; this is of particular interest when you're driving a 5,000-gallon** *water tender*

Narration Script: Two of the eighteen "Watch-out" situations you learned about earlier in this course deal with not scouting a fire scene and operating in an area at night that you've never seen in daylight. Of course, you can't walk every inch of your jurisdiction, but the more you know about it, the fewer unpleasant surprises you'll run into. Forgotten your Watch-Out situations? You can always refer to your IRPG where they are conveniently listed as a healthy reminder to all firefighters.

Pre-designated components

Examining maps and touring your territory will help you identify valuable resources you can use in a wildland fire incident. Keep your eyes open for:

- **Access roads**
- **Vehicle staging areas**
- **Hand crew staging areas**
- **Other ICS functional bases**

Read the following to learn more about each resource.

Access Roads

Pre-designate certain roads or highways for firefighters to use for access to a property. Take into account other traffic likely to be using those routes, such as:

- **Normal vehicular and pedestrian traffic**
- **Those trying to flee from or return to their threatened property**
- **Media vehicles and personnel**
- **Spectators**

In cooperation with local law enforcement, the plan may pre-designate closing certain sections of highway to all but emergency vehicles and owners of threatened properties.

Vehicle Staging Areas

During pre-incident planning, identify sites that could serve as staging areas for engines and heavy equipment. Virtually any large, open space will do, such as parking lots of:

- **Schools**
- **Churches**
- **Shopping centers**

Note when these areas are not likely to be available—such as when schools and churches are in session and during regular business hours. Staging areas should provide adequate size and configuration, easy ingress and egress, adequate lighting, and available sanitary facilities.

Hand Crew Staging Areas

Staging areas for hand crews should have the minimum amenities needed, including:

- **Shade**
- **Drinking water**
- **Sanitary facilities**

Bear in mind when evaluating possible hand crew staging area sites, you need to keep inmate and non-inmate crews separate.

Other ICS Functional Bases

During pre-incident planning, identify other sites as possible locations for:

- **Incident command posts**
- **Incident bases**
- **Helibases and helispots**
- **Safety zones**
- **Other facilities designated in the incident command system**

When evaluating sites, consider the different requirements each of these functions have in terms of the amount of space needed, the absence of obstructions, the view provided, and the ease of access.

Narration Script: Why re-create the wheel if you don't have to? Look for areas within your jurisdiction that can be repurposed to support wildland fire fighting efforts in an emergency.

Knowledge Check 4

Matching—select the match you choose from the pull down list.

You've got several maps on the rig. Which map will tell you what you need to know?

Match each map element with the correct map type.

Street addresses	Aerial photograph
Ridges and valleys	Aerial photograph
Permanent structures	Aerial photograph
Scale geographic measurements	Aerial photograph

The correct matches are as follows:
Street addresses: General plot map
Ridges and valleys: Topographic map
Permanent structures: Aerial photograph
Scale geographic measurements: Orthophoto map

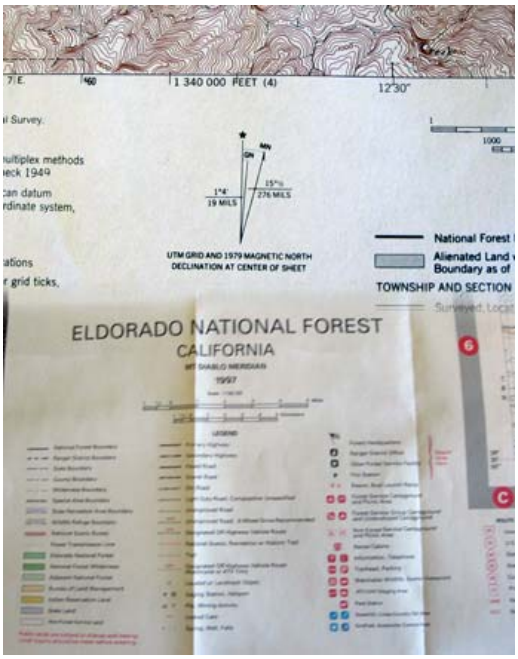
Map symbols

Before you can use any map, you have to understand what the symbols on the map mean. Maps use symbols to represent different types of terrain and features. Most maps include a table—called the *legend*—defining the symbols used and providing some other information as well.

Symbols will vary among different types of maps, but here are a couple of things you'll find in the legend of almost every map:

- **Map name—the name or title of a map gives you a general idea of the area the map covers**
- **Map scale—the factor reducing large distances in the real world to smaller distances represented on the map. For example, an inch on the map may represent 5 miles of actual distance.**

Narration Script: A map legend is the equivalent of a map code breaker—it explains the maps symbols, lines, and unique features. However, what you find in the legend depends on the map. Generally, you'll usually find two very important pieces of information—the map name and the map scale. The map name tells you what general area is represented on the map. The scale tells you how much area is shown.

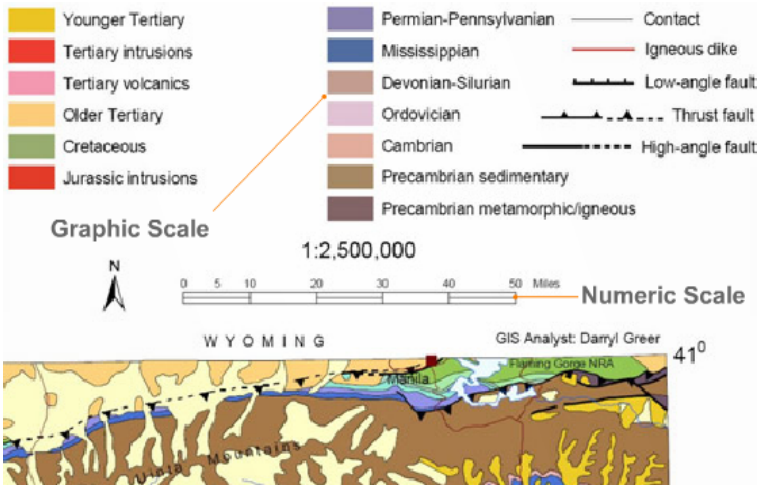


Caption: An example of a map legend.

Map scale

The map scale is often given in two different ways:

- **Numeric—The scale is stated as a ratio of units on the map to units in the real world. For example, a scale of 1:24,000 means that 1 inch on the map equals 24,000 inches—or 2,000 feet—on the ground.**
- **Graphic—The scale is represented in graphical form with a line or bar marked with the equivalent distance on the ground.**



Caption: An example of graphic and numeric scales.

North arrow

Most maps also include a north arrow to help you orient the map correctly. In most cases, the map is drawn with north at the top. Still, you'll usually find a north arrow in the legend or in a blank space on the map where there are few significant features. The north arrow is

especially important for reading topographic maps and navigating with a compass. You'll learn more about the importance of the north arrow later in this topic.

Narration Script: Which way is up? On most maps, north is toward the top of the map. However, it's a good idea to look for the north arrow. The north arrow will be especially important when you start learning to use a map with a compass later on in this topic.

Knowledge Check 5

Matching—select the match you choose from the pull down list.

There are all kinds of maps and each type includes different sets of features. But there are some common elements you'll find on almost any map.

Match each map element to its function.

Map name	Provides a visual comparison of map and real-world distances
Numeric scale	Provides a visual comparison of map and real-world distances
Graphic scale	Provides a visual comparison of map and real-world distances
North arrow	Provides a visual comparison of map and real-world distances

The correct matches are as follows:
Map name: Describes the area covered
Numeric scale: Gives the ratio of map distances to real-world distances
Graphic scale: Provides a visual comparison of map and real-world distances
North arrow: Indicates the correct orientation of the map

Map reading for navigation

Now that you have a feel for some of the types of maps you can use, it's time for a lesson in reading the lay of the land. Map reading for navigation is both skill and art. Developing skill in navigating with maps takes practice.

Useful maps for navigation include:

- **Latitude and longitude maps**
- **Land survey maps**
- **Topographic maps**

You will examine each map type in turn to start getting your bearings.

Narration Script: Navigation is one of the oldest uses for maps. Before you can use any map to find your way around, you have to understand how distances and directions are represented on the map. Examine the three types of maps commonly used for navigation. Some of the map types build on each other, so we suggest you investigate them in this order.

Latitude and longitude maps

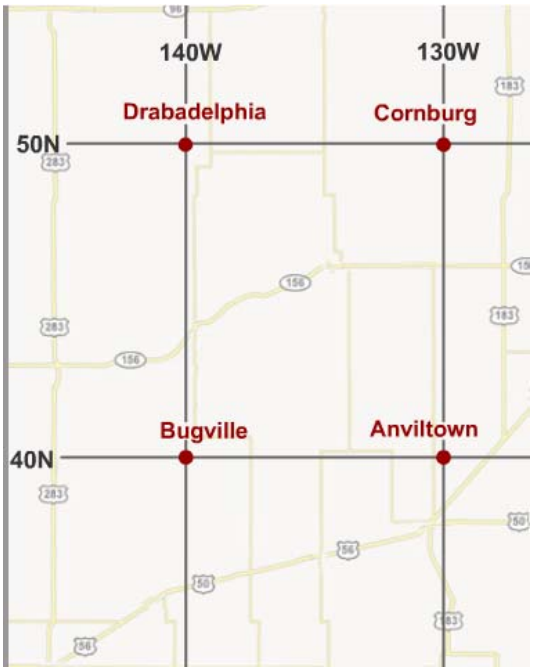
Latitude and longitude maps are among the most familiar types of maps. You probably saw plenty of them in geography class in school.

Latitude and longitude are measured in degrees, minutes, and seconds. There are 360 degrees in a full circle, so one degree of longitude or latitude is 1/360th of the distance around the earth. Degrees are further divided into *minutes* and *seconds*.

- **One minute of latitude or longitude is 1/60th of a degree**
- **One second is 1/60th of a minute**

Narration Script: "X" marks the spot—at least on some maps laid out in rectangular blocks with sides parallel to latitude and longitude lines. When you read latitude and longitude lines, the degrees of latitude and longitude are reported in degrees, minutes, and seconds. Latitude is measured in degrees north and south of the equator.

You might have to point out a fire's location or point of origin by specifying the exact latitude and longitude—especially when communicating with pilots doing airdrops. Without any solid reference point like a road, this method is your best bet.



Caption: An example of a latitude and longitude map.

Latitude

Latitude measures the distance north or south of the equator. The equator is 0 degrees latitude while the geographic North Pole is 90 degrees north latitude.

Latitude lines run parallel to each other, so they're always the same distance apart. In approximate distances:

- **One degree of latitude = 69 miles (111 km)**
- **One minute of latitude = 1.15 miles (1.85 km)**
- **One second of latitude = 100 feet (30 m)**

Narration Script: Lines of latitude are parallel—and it might help to think of them like rungs of a ladder. Because the latitudinal lines are parallel, the distance between them always remains the same.

Longitude

Longitude measures distance east or west of the prime meridian—an imaginary line running from the North Pole to the South Pole passing through Greenwich, England. The prime meridian is 0 degrees longitude.

Longitude lines converge at the Poles, so the distance between longitude lines decreases as you move farther from the equator and closer to the poles. For example, one degree of longitude at the equator equals 69 mi. (111 km), but at Boise, Idaho, one degree equals just 53 mi. (85 km). If you're just a step away from the North Pole or the South Pole, one degree of latitude equals less than 1 in. (2.5 cm).

Narration Script: Longitude is also measured in degrees east and west of the prime meridian, which runs between the North and South Poles through Greenwich, England. However, lines of longitude are not parallel—they converge at the Poles. The closer you are to the Poles, the smaller the distance between longitude lines.

Using latitude and longitude

When you describe a location using latitude and longitude, it's conventional to give the latitude first. Give the latitude to the appropriate level of precision using degrees (°), minutes (′), and seconds (″). Then indicate the direction from the equator by adding "north latitude" or "south latitude." After you've given the latitude, give the longitude in the same way, except specify whether you're referring to "west longitude" or "east longitude."

Narration Script: When you're giving a location using latitude and longitude, it is normal practice to give the latitude first. For example, if you're giving the exact location of the world's largest ball of twine in Cawker City, Kansas, you would say it's located at 39 degrees, 30 minutes, 33 seconds north latitude, and 98 degrees, 26 minutes, 2 seconds west longitude. And don't forget to send postcards to your friends back home when you get there.

Knowledge Check 6

Multiple choice—check the box of the answer(s) you choose.

You're at the scene of a fire and you've been asked to call for an airdrop and communicate the coordinates to the pilot in standard form.

Identify the coordinates expressed in standard form.

- ☐ **34 degrees 30 minutes latitude, 120 degrees 12 minutes longitude**
- ☐ **34 degrees 30 minutes north latitude, 120 degrees 12 minutes west longitude**
- ☐ **120 degrees 12 minutes west longitude, 34 degrees 30 minutes north latitude**
- ☐ **34 to 30 degrees latitude north, 120 to 12 degrees longitude west**

The correct answer is 34 degrees 30 minutes north latitude, 120 degrees 12 minutes west longitude.

Land survey maps

Land survey maps are used to describe legal land locations for property boundaries. They're used primarily by surveyors, land management agencies, government agencies, and anyone who needs legal land descriptions.

There are two land survey systems in use in the United States:

- **Metes and bounds system**
- **Public land survey system**

We'll discuss each land survey system in turn.

Narration Script: Land survey maps show the legal boundaries for describing land ownership. These maps don't rely on longitude and latitude to describe specific locations. Instead, they describe locations in terms of distances from a fixed point. There are two types of land survey maps—the metes and bounds system and the public land survey system.

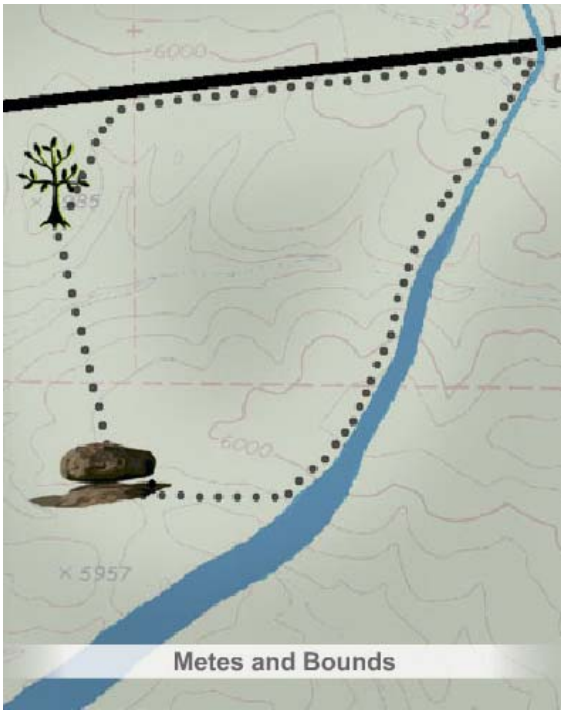
Metes and bounds

The metes and bounds survey system was used to survey the original American colonies. Most states east of the Mississippi are surveyed in metes and bounds. Under this system, the boundaries of tracts of land are described using landmarks such as streams, rock formations, public roads, or even large, distinctive trees.

Metes and bounds descriptions are lengthy descriptions in surveyor's terminology. As a result, maps based on metes and bounds surveys don't provide a systematic way to describe a specific location, so they're of little use to fire fighting agencies.

Narration Script: Dusty map, anyone? One system of land surveying dates back to before the American Revolution. Under this system, the boundaries of a tract of land are described in

relation to natural landmarks and boundaries. This system results in tracts of land varying in size and shape. The landmarks used to describe boundaries may change over time if a stream erodes a bank or that distinctive tree dies and is cut down. Metes and bounds surveys aren't very useful to firefighters.



Caption: An example of a metes and bounds map.

Public land survey

The public land survey system is used to describe legal land boundaries and locations in a grid of townships, ranges, and sections. Most states west of the Mississippi and north of the Ohio Rivers were surveyed after passage of the 1796 Public Land Survey law and follow this system.

Locations within this grid are described in relation to 35 initial points or reference locations. Two lines run through each initial point—a baseline and a principal meridian. Baselines run east and west and principal meridians extend north and south from each initial point.

Narration Script: The public land survey system was conceived by Thomas Jefferson and came into use in the 19th century. The public land survey system uses 35 reference points to create a grid of lines that can be used to create legal descriptions of tracts of land. Each initial point is at the intersection of a baseline running east and west and a principal meridian running north and south.

Caption: An example of a land survey map.

Township and range lines

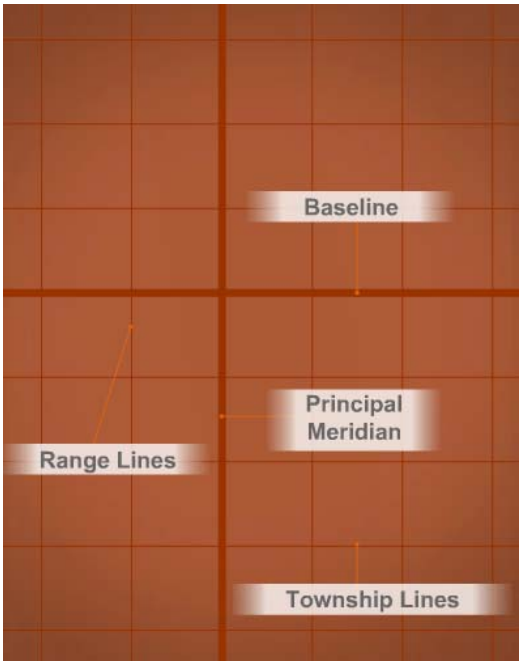
Township lines run parallel to baselines. If you think of a baseline as being like the equator, township lines are like latitude lines. They measure distance north or south of the baseline. Township lines are 6 miles apart.

Meridians or range lines run parallel to the principal meridian, also at 6-mile intervals. You can think of range lines as being similar to (but not exactly like) longitude lines.

The township lines and range lines form a grid with the initial point at the center. Each of the squares in the grid measures 6 miles on each side. This grid is used to divide the land into:

- **Townships**
- **Sections**
- **Section subdivisions**

Narration Script: You can plot the location of any specific place by describing how far it is from the nearest baseline and principal meridian. Think of the baseline as being like the equator. As you move north or south of the baseline, there are township lines at 6-mile intervals, just like latitude lines. To measure the distance of a location from the baseline, just count the township lines. Likewise, there are range lines running parallel to the principal meridian. You can measure how far a location is from the principal meridian by counting the range lines.



Caption: An example of a key township and range lines.

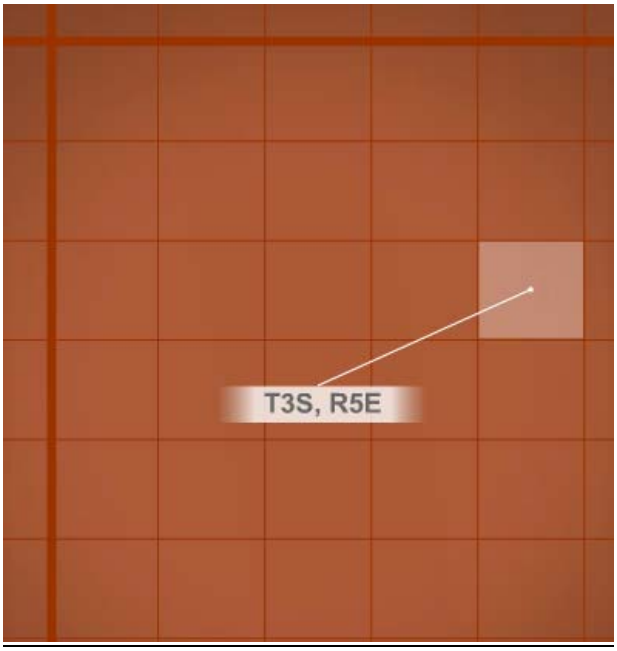
Townships

Each of the squares on the grid is called a township. (Be careful not to confuse a township—a square area of land—with the township *lines* discussed earlier.) A township measures 6 miles by 6 miles or 36 sq. mi. (93.6 km^2). You can describe the location of a township in relation to the initial point by counting the rows and columns—or ranks and ranges—of squares in the grid.

For example, the township located three rows (or ranks) of townships south of the baseline and five columns (or ranges) east of the principal meridian can be written as "township three south, range four east," or T3S, R5E.

On a land survey map, you'll see the township numbers in the side margins of the map and the range numbers in the top and bottom margins.

Narration Script: The township lines and range lines form a grid of squares measuring 6 miles on each side. These squares are called townships. To describe the location of a township, you can give its coordinates in the grid. All of the townships in the third rank of townships south of the baseline would have the coordinate T (for township)-3-South. The townships in the fifth rank of townships east of the principal meridian would have the coordinate R (for range)-5-East. The combination of these two coordinates describes the location of just one township at T-3-South, R-5-East.

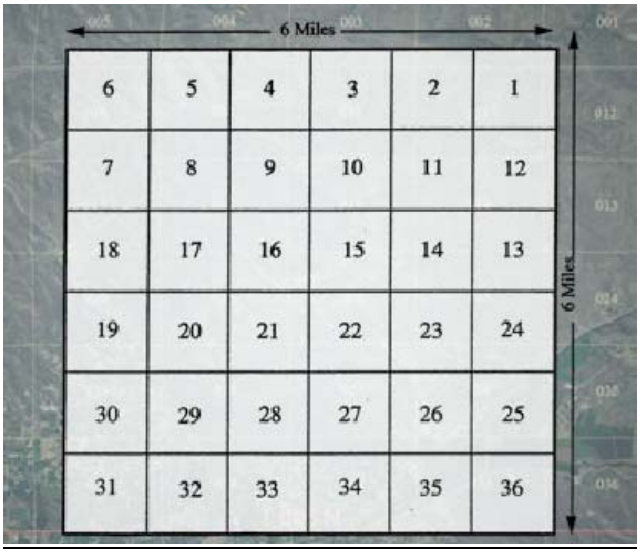


Caption: An example of a particular location on a public land survey map.

Sections

Each township is divided into 36 numbered *sections*. Sections are always numbered starting with section 1 in the northeast corner and moving west to section 6. The next row of sections to the south is numbered from west to east. Section 7 sits directly south of section 6. Numbering continues back to section 12 at the eastern border of the township. The sequence of section numbers continues to alternate west to east and then east to west until you get to section 36 in the southeast corner of the township.

Narration Script: Every township is divided into 36 sections. The sections are numbered sequentially starting in the northeast corner of the township. The northernmost row of sections is numbered from 1 to 6 moving from east to west. Then the sequence reverses. The next row of sections to the south is numbered from 7 through 12 moving from west to east. The numbering continues with this pattern and ends with section 36 in the southeast corner.



Caption: An example of the section grid making up a township.

Locating sections

To designate the location of a township section, just add the section number to the township location. For example, the location of section 22 of township T3S, R5E can be written as S22, T3S, R5E.

Each section equals 1 sq. mi. or 640 acres (259 ha). The boundaries of sections are also measured in a surveying measure called *chains*. One chain equals 66 ft. (20 m), so each side of a section measures 80 chains.

However, be aware that townships, sections, and section subdivisions may vary slightly in size. They can be larger or smaller than standard dimensions where survey errors or corrections have been made.

Narration Script: To identify a section, just give the section number and then the township location. Sections and townships are laid out using a surveying measure called chains. Each section of a township measures 80 chains on each side. A section is one mile square, so 80 chains equals 1 mile. If you do the math, you'll find one chain equals 66 feet or just a little more than 20 meters.

Quarter sections

Sections can be further divided into *quarter sections* of 160 acres (65 ha). A quarter section measures 40 chains on each side. Quarter sections are described by their location in relation to the center of the section. For example, the location of a quarter section on the north and west side of a section is written as NW1/4. Quarter sections are not shown on field maps.

To identify a location down to the quarter section, add the quarter section description to the section, township, and range. For example, the southwest quarter of section 22, township 3, range 5 is written as SW 1/4, S22, T3S, R5E.

Narration Script: Sections are divided into quarter sections measuring 40 chains or a half-mile on each side. You can describe a quarter section by giving its location in relation to the center point of the section—northeast, northwest, southeast, or southwest.

Quarter of a quarter sections

Quarter sections can be even further subdivided into quarter of a quarter sections equaling 40 acres (16 ha) and measuring 20 chains on each side. They are referred to in the same way quarter sections are. The northwest quarter of the southwest quarter of section 22, township T3R5 is written SW1/4, NW1/4, S22, T3S, R5E.

Narration Script: You might have guessed it—but each quarter section can be divided into quarters again. A quarter of a quarter section measures one-fourth mile or 20 chains on each side and covers an area of 40 acres.

Topographic maps

USGS topographic maps are the most popular maps used by fire agencies showing information such as:

- **Terrain**
- **Water sources**
- **Roads and improvements**
- **Township and section boundaries from public land surveys**
- **Latitude and longitude**

The USGS publishes maps in different quadrangle sizes. Commonly used maps include 7.5 minute quads and 15 minute quads. The numbers indicate how many minutes of latitude are shown on the maps. Map scale for 7.5 minute quads is normally 1:24,000 scale and for 15 minute quads it's normally 1:62,500.

Narration Script: Topographic maps—or "Topo maps" for short—from the U.S. Geological Survey are popular with fire agencies because they show information useful to firefighters. The maps come in different scales. The most commonly used maps cover seven and half minutes or 15 minutes of latitude.

Multiple north arrows

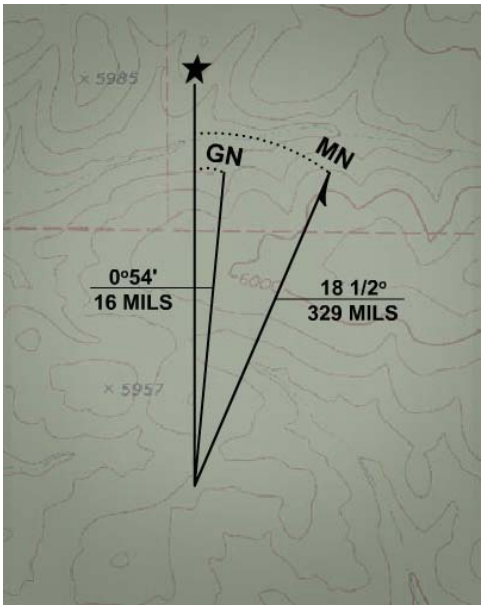
The north arrow helps you orient the map by, well … pointing to north on the map. But it gets trickier. On USGS topo maps, there are three indications of north:

- **Navigational north—the direction toward the North Star**

- **Geographic or "true" north—the direction to the geographic North (GN) Pole of the earth**
- **Magnetic north—the direction a compass needle points, to the magnetic North (MN) Pole**

In most locations in North America, these three differ slightly from each other. When you learn about navigating with a compass later in this topic, you'll also learn why these differences are important.

Narration Script: The north arrow on a map tells you which way is north. Most people, as a matter of habit, read maps with north pointing up. However, on a USGS topo map, there are three arrows pointing to the north, and often they're not pointing in exactly the same direction. The arrow marked with a small star shows navigational north—the direction to the North Star. The arrow marked G-N points to the North Pole, or geographic north. The arrow marked M-N points to magnetic north. That's the direction a compass will show as north.



Caption: An example of the north arrows on a topographic map.

Topo map features

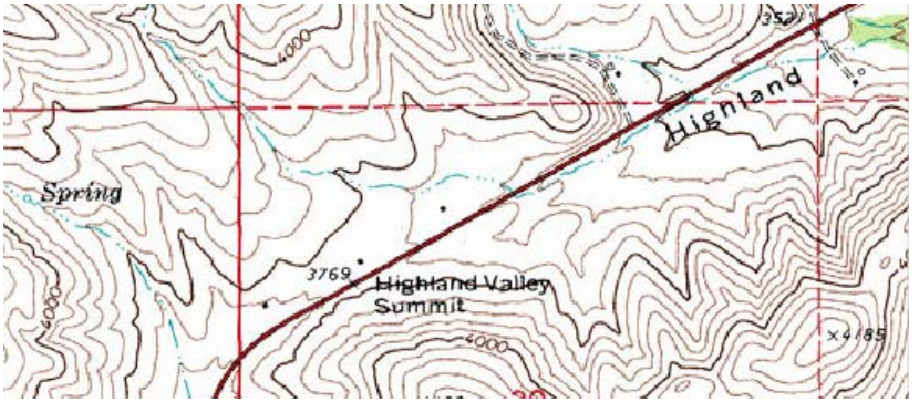
Topo maps use specific symbols and colors to represent different kinds of land features. Some of the most prominent symbols include:

- **Elevation features**
- **Water features**
- **Vegetation features**
- **Human-made features**
- **Survey lines**

Read the following for examples of each symbol type.

Elevation Features

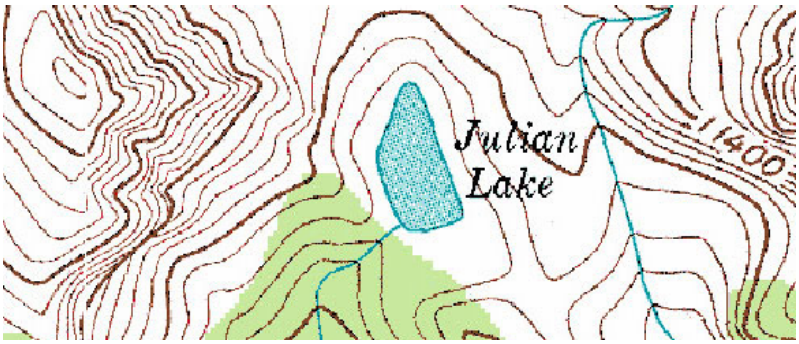
Elevation features on topo maps include high elevations like peaks and ridges and low elevations, like depressions. Single points of elevation are marked with a small cross and a notation giving its elevation in distance above sea level. The topography of the land is indicated with curving brown *contour lines.*



Caption: An example of contour lines on a topographic map identifying a variety of elevation features.

Water Features

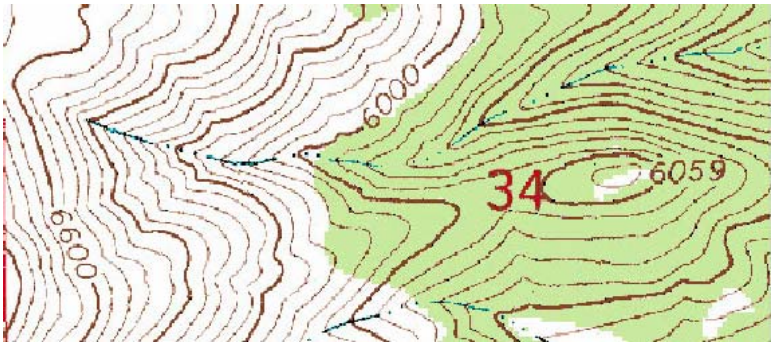
Water features on maps include oceans, lakes, streams, intermittent streams, and reservoirs. Water features typically appear in blue.



Caption: An example of water features on a topographic map.

Vegetation Features

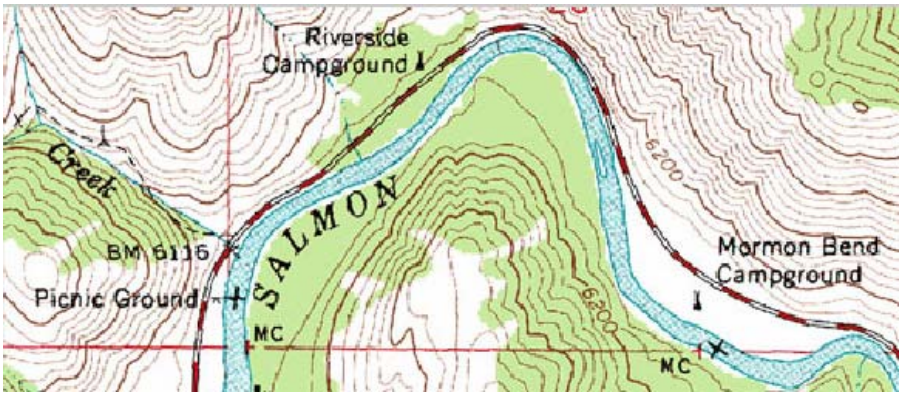
Vegetation features include forests, grasslands, parks, or brush. Forested areas appear as a patch of solid green. Brush land and grassland appear as patterned areas of green.



Caption: An example of vegetation marked in green on a topographic map.

Human-Made Features

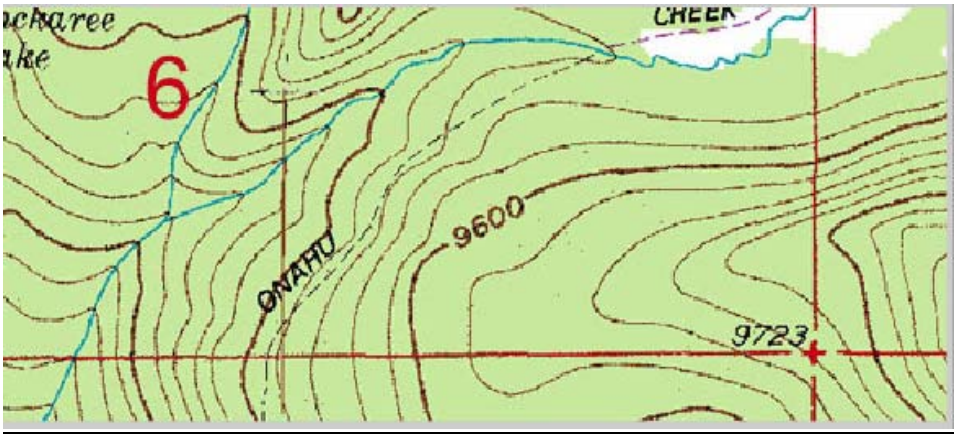
Human made features can include physical objects like buildings, roads, airports, pipelines, and dams. They can also include intangible features like the boundaries of cities, counties, or other governmental jurisdictions. Most human-made features appear in black on maps, but major roads appear in red. Densely populated areas appear in pink.



Caption: An example of a campground and a picnic ground marked on a topographic map.

Survey Lines

Township and range lines are shown on the map in red. In addition, survey data such as township section numbers and elevations at section corners are also shown in red.



Caption: An example of township and range lines found on a topographic map.

Narration Script: Topo maps are developed from aerial and satellite photos and then checked for accuracy by a field observer. They show a wide range of surface features.

Fire mapping

Most *incident commanders* (ICs) place a clear plastic overlay on top of a topo map and plot the burned area, predicted path of the fire, and locations of *firelines*, command centers, and *staging areas*. Fire mapping techniques are beyond the scope of this topic. Refer to Appendix A of the Fireline Handbook for a table of commonly used display symbols for fire mapping. You'll also find a chart of conversion factors for translating map scales into familiar distance equivalents.

Contour lines

The distinguishing feature of a topo map is the web of curving brown contour lines. Here are a few basics for interpreting contour lines:

- **Every point along a single contour line is at the same height above sea level.**
- **The difference in elevation between contour lines is the same for all contours on a map. The difference is called the contour interval of the map.**
- **Index contours are accentuated contour lines numbered with the elevation at the line. On USGS maps, every fifth contour line is an index contour.**

On most topo maps, the contour interval will be noted in the legend. However, it's easy to calculate the contour interval. Here's an example of calculating the contour interval. The distance between index contour lines on this map is marked in 200-foot increments. There are five intervals or spaces between index contours. If you divide the change in elevation between index contours—200 feet—by five, you find the contour interval of the map is 40 feet.

Narration Script: If your map looks like someone dumped a plate of spaghetti on it, it's probably a topo map. All those wavy brown lines represent elevations above sea level. As you move from one line to the next, the elevation of the terrain rises or falls. The elevations are marked in feet on the dark brown index contours.

Caption: An example of contour lines on a topographic map.

Properties of contour lines

The contour lines on a topo map are drawn according to consistent rules. Here are some basic properties of contour lines:

- **Contour lines never come to a dead end. Each line must eventually close upon itself either on or off the map.**
- **A contour line cannot branch or "y" into two separate contours.**
- **Contour lines don't cross or meet, except in very unusual cases such as waterfalls, or overhanging cliffs.**
- **Contour lines are not drawn through buildings or other constructed objects.**

Narration Script: Here are a few basic rules to help you understand contour lines. They don't dead end, split, or pass through buildings or other constructed objects, and they meet or cross only under very, *very* unusual circumstances.

Contour lines and slope

Changes in the shape of contour lines and the distances between lines reflect the *slope* of the terrain. As you gain experience reading topo maps, you'll come to recognize some familiar patterns.

Read the following to learn more.

Contours Close Together

Contours close together indicate a steep slope. Each contour line represents a change in elevation, so if the lines are close together, the elevation is changing rapidly.

Contours Spread Apart

Where contours are spread far apart, the terrain is flat or has a very gentle slope. You have to cover a lot of ground before the elevation changes.

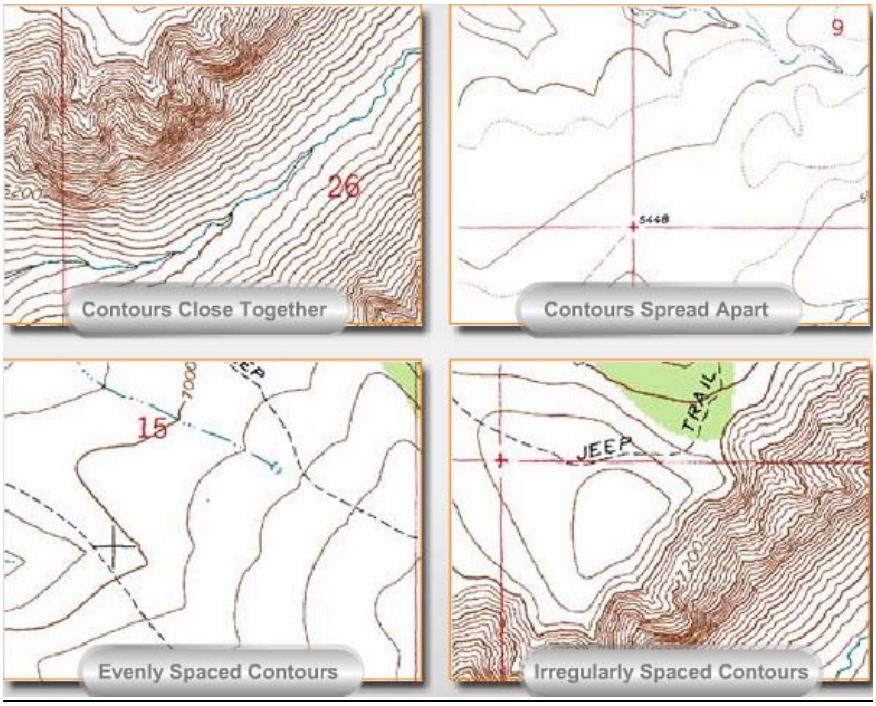
Evenly Spaced Contours

If contour lines are evenly spaced, the terrain has an even, consistent slope. The change in elevation is consistent as you travel.

Irregularly Spaced Contours

If the slope of the terrain is rugged and uneven, the contour lines will be irregularly spaced. Steep slopes are intermingled with milder slopes and flat areas.

Narration Script: Now you're getting to the good part of learning about topo maps. Here's where you start learning to turn the lines on the map into a mental image of the terrain. On a map, you will notice the contour lines are close together in some places and far apart in others. Sometimes they're at regular intervals, and other times they're unevenly spaced. Each line represents a change in elevation, so the distance between the lines tells you how rapidly the elevation changes. Where the elevation changes rapidly, you're on a steep slope.



Caption: An example of various contour lines on topographic maps. The contour lines indicate varying degrees of slope and elevation change.

Contour lines and terrain features

Contour lines form distinctive shapes that reflect certain terrain features. Contour lines always run perpendicular to the direction of the maximum slope. Contour lines in tightly closed rings represent a high or low point like a summit or a depression.

You can distinguish between summits and depressions by looking for tick marks on the inside of closed contours that indicate depressions. Contour lines form U's when they cross a ridge or outcropping. The bottom of the U's point down the slope.

Narration Script: With practice, you'll begin to recognize some of the familiar patterns contour lines make. A contour line in a small, closed ring shows where there is a summit or depression. Contour lines forming a series of curves that look like the letter U indicate a ridge or outcropping. The bottoms of the U's point down the slope.

Contour lines and streams

So far, you've seen how to recognize slopes, peaks, and ridges. Low-lying terrain also creates distinctive patterns of contour lines.

Read the following to learn more about low-lying terrain.

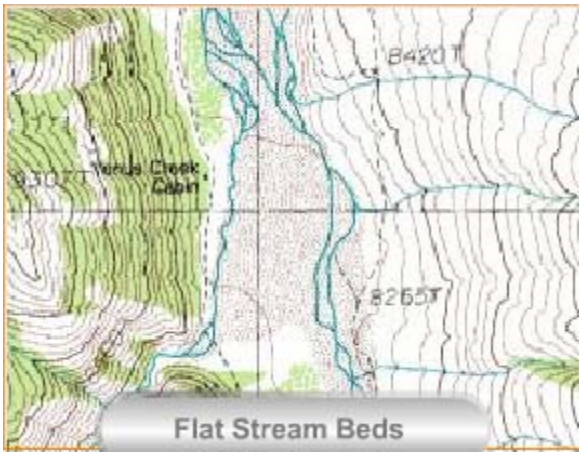
Stream Beds on Slopes

Because of gradual erosion, stream beds are lower than the surrounding terrain. When contour lines cross a stream bed in sloping terrain, they form sharp points resembling the letter V. The V's point upslope and upstream. Longer V's represent steeper slopes and streams cut deeper into the hillside.

Caption: An example of a sloping stream bed as indicated on a topographic map.

Stream Beds on Flat Terrain

On flatter ground, contour lines run parallel to streams. The banks of the stream are higher than the stream bed below, so the contours outline the stream on the map.



Caption: An example of a flat stream bed as indicated on a topographic map.

Canyons and Valleys

Canyons appear on the map as narrow, flat areas with tight bunches of contour lines indicating steep canyon walls on either side. The fingers of canyons end in V-shaped drainages where water flows down into the canyon. As with stream beds, the V's point

upslope. Valleys have a similar appearance, but the contour lines are more widely spaced because the surrounding slopes aren't usually as steep as canyon walls.

Caption: An example of a canyon as indicated on a topographic map.

Narration Script: Contour lines on a topographic map will tell you all about the terrain. They are especially helpful for identifying steep slopes, flat areas, and mountain peaks or hilltops. We've talked in length about the impact of a fire's behavior in and around canyons and ridges, so check out where they are when you're out on the fireline.

Compass navigation

Traveling across wild terrain with only a map is difficult. You also need a compass to find your bearing and stay on course. Using a compass is an age-old navigating skill. The basic concepts include:

- **Parts of a compass**
- **Shooting an azimuth**
- **Adjusting for declination**
- **Navigating with a compass**

You will investigate each concept in this order.

Narration Script: Travelers and explorers have used compasses with maps for centuries. There's no reason why you can't use a compass too. As you will see, using a compass is a little more complicated than just checking to see which way the needle is pointing. However, once you know the basic concepts, you can practice using your compass on the bike trail or on a weekend fishing trip.

Parts of a compass

Most handheld compasses used in wildland fire fighting are the liquid-filled type.

Read the following to learn more about each part of the compass.

Magnetic Needle

The magnetic needle is suspended on a pivot inside the dial. The needle swings freely so the red side can always point toward magnetic north. Some compasses have a luminous point at the tip of the needle for use at night.

Dial

The dial is the round revolving housing sitting over the magnetic needle. The rim of the dial is marked with the four cardinal directions: north, east, south, and west. The dial is also divided into 360 degrees. Each mark on the dial represents two degrees, and every 20th degree is marked with a number from 20 to 360. Zero degrees, 360 degrees, and North are all the same.

Travel Arrow

The travel arrow is marked on the base plate above the dial. Use this arrow to indicate your direction of travel over the ground when you're taking a reading. Many compasses have a luminous point at the tip of the travel arrow. The travel arrow extends to a small white mark under the dial, called the index pointer.

Orienting Arrow

The orienting arrow is a fixed marking located inside the dial. It rotates with the dial so it's always pointing to the dial's North marking. On some compass models, the orienting arrow can be adjusted to compensate for declination. Your compass may have luminous points to make the orienting arrow visible in the dark. Orienting lines run parallel to the orienting arrow. They're useful for aligning the orienting arrow with lines on a map.

Scales and Aid Lines

Various scales are marked on the top and the sides of the compass to help with map reading. The scales correspond with typical topographic map scales. Aid lines are marked on the base plate parallel to the travel arrow. These lines help align the compass on a map.

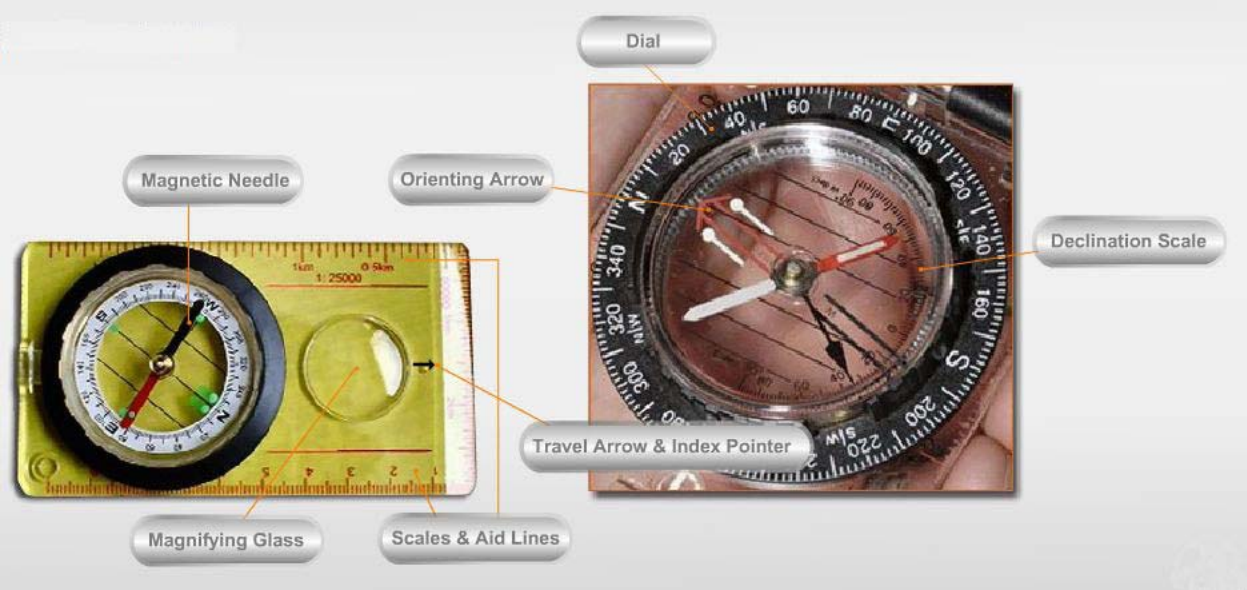
Magnifying Glass

Many compasses have a magnifying glass just behind the travel arrow. It's there to help you read small notations and details on a map.

Declination Scale

The declination scale is located inside the main dial and shows the degrees of variation between magnetic north and true north. This scale is used to calibrate the compass for the declination in your specific location.

Narration Script: Before you can learn how to use a compass, you need to know the names of all the parts. Firefighters most often use liquid filled compasses like this one. Compass features vary among different manufacturers and models.



Caption: The parts of a compass.

Azimuths

Azimuths, or bearings, are angles between two horizontal lines. One line points to the north and the other points in the direction you want to travel. Azimuths, like other angles, are expressed in degrees.

Knowledge of these directions is useful, but it's not sufficient for describing or finding an exact azimuth. You can use the degree marks on the dial of your compass to find more precise bearings.

Narration Script: If you only want to walk north, you don't need to know much about a compass—just follow the magnetic pointer. But if you need to head in any other direction, you need to understand azimuths or bearings. An azimuth is the angle between straight north and the direction you want to travel.

Shooting an azimuth

The process of finding a direction with your compass is called "shooting an azimuth." To shoot an azimuth:

- **Turn the dial—turn the dial of your compass until the desired heading lines up with the index pointer and travel arrow**
- **Turn your body—while holding the compass level with the travel arrow pointing away from you, turn your body until the magnetic needle lines up with the orienting arrow**

The travel arrow now points in the direction of your bearing. Don't forget an azimuth is an angle. One line in the angle aligns with the magnetic needle and orienting arrow pointing north. The other leg of the angle is your desired bearing, and it aligns with the travel arrow and the index pointer.

Narration Script: Shooting an azimuth with your compass takes just two steps. First, turn the compass dial until your desired heading lines up with the index pointer. Now turn your body until the magnetic needle lines up with the orienting arrow. The travel arrow is pointing in the direction you want to travel.

Calculating a back azimuth

A *back azimuth* is the opposite bearing from an azimuth. It's useful when you have to turn around and retrace your steps. A back azimuth is 180 degrees from the direction of travel. To calculate the back azimuth:

- **Add 180 to the azimuth, if your bearing is 180 degrees or less**
- **Subtract 180 from the azimuth, if your bearing is 180 degrees or more**

Here are some examples:

- **If your direction of travel is 140 degrees: 140 + 180 = 320 degrees back azimuth**
- **If your direction of travel is 240 degrees: 240 - 180 = 60 degrees back azimuth**

Narration Script: If you overshoot your destination or need to double back for any other reason, just do a one-eighty. The opposite direction from an azimuth is called the back azimuth. It's like a trail of bread crumbs—it points you to go back the way you came.

Knowledge Check 7

Multiple choice—check the box of the answer(s) you choose.

You've been asked to shoot an azimuth of 200 degrees using your compass.

Choose your first step for shooting the azimuth.

- ☐ **Turn the dial until 200 degrees lines up with the magnetic needle**
- ☐ **Turn your body until the magnetic needle lines up with 200 degrees**
- ☐ **Turn the dial until the orienting arrow lines up with the magnetic needle**
- ☐ **Turn the dial until 200 degrees lines up with the index pointer**

The correct answer is turn the dial until 200 degrees lines up with the index pointer.

Knowledge Check 8

Multiple choice—check the box of the answer(s) you choose.

You've been asked to shoot an azimuth of 200 degrees using your compass. Your first step should be to turn the dial until 200 degrees lines up with the index pointer.

Choose your NEXT step for shooting the azimuth.

- ☐ **Turn your body until the red side of the needle lines up with the orienting arrow**
- ☐ **Turn your body until the white side of the needle lines up with the orienting arrow**
- ☐ **Turn your body until the red side of the needle lines up with 200 degrees**
- ☐ **Turn your body until the red side of the needle lines up with the travel arrow**

The correct answer is turn your body until the red side of the needle lines up with the orienting arrow.

Adjusting for declination

You'll often use your compass with a map. Here's the tricky part—*all* compasses point to *magnetic north,* but most of the maps you use are based on *true north*. The distance between magnetic north and true north in any location is called the *magnetic declination*. You need to compensate for the difference between true north and magnetic north to get an accurate bearing.

Narration Script: Which way is north? Well, that depends on whether you're looking at your map or your compass. Most maps are drawn with north aligned to the geographic North Pole, or true north. Compasses point to the magnetic North Pole, and that's not the same place.

The difference is called magnetic declination, and it's an important concept if you want to plot an accurate heading to a location on a map. You have to compensate for the difference between true north on the map and magnetic north on your compass.

Agonic line

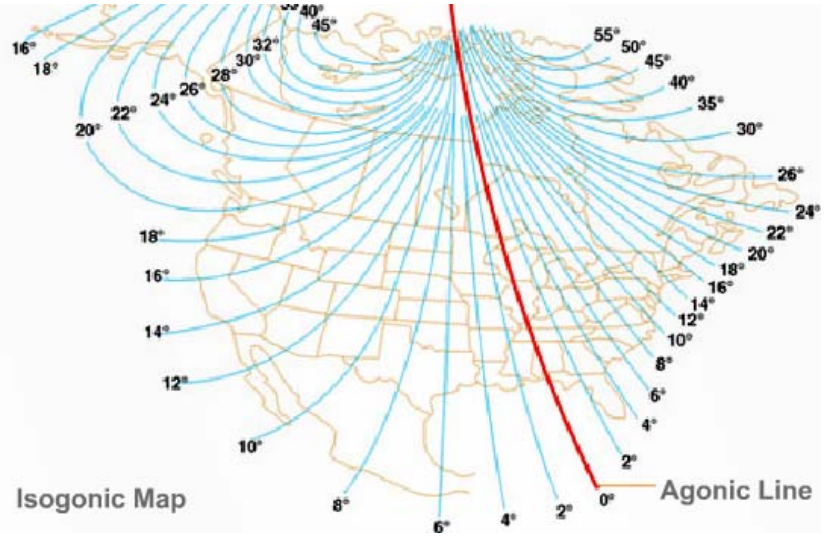
Depending on your location in the world, magnetic declinations will vary. In locations where magnetic north and true north line up with each other, the declination is 0 degrees. These locations lie on a straight line running north and south called the *agonic line*.

If you're east of the agonic line, your compass will point west of true north. Locations east of the agonic line are said to have a western declination. Similarly, locations west of the agonic line have an eastern declination.

Narration Script: In locations on the *agonic line,* magnetic north lines up with true north. These locations have a 0-degree declination. The line runs north from a point in far western Florida through Alabama, Tennessee, Kentucky, Illinois, Wisconsin, Minnesota, Ontario, Manitoba, and

the Northwest Territories. This line acts like a baseline for resetting your compass depending on your location in the world.

Areas east of the agonic line have a western declination because a compass needle in these areas will point west of true north. For the same reason, your compass will point west of true north when you're east of the line. That's called an eastern declination. For example, in California, declination varies from about 14 degrees East in the southern part of the state to about 17 degrees East in the northern part. The USGS publishes isogonic maps showing declination readings for various parts of the continent.



Caption: The agonic line depicted on an isogonic map.

Declination resources

USGS topo maps show the magnetic declination. The declination at the center of the map is notated in the margin. One arrow, marked GN, points straight up to geographic or true north. Another arrow, marked MN, points to magnetic north. The degrees of declination are noted to one side.

The declination in any given area changes so gradually, it's considered to be constant. So, once you've determined the declination for your area, there's no need to do it again unless you're leaving the area.

Here's some information about declination resources. The declination for any area in North America can be obtained from isogonic or topographic maps available from:
U.S. Geological Survey (USGS)
Box 25046
Denver, CO 80225

The toll-free number is 1-888-ASK-USGS (1-888-275-8747).

Setting declination for compasses with adjustable scales

There are several ways to set declination on a compass. Some compass models like the Silva Ranger have an adjustable scale you can set to a local declination. Adjusting the scale moves the orienting arrow so it points to the degree of declination instead of 0 degrees. The magnetic needle will continue to point to magnetic north, but the scale on the dial will show azimuths in relation to true north as shown on a map.

Narration Script: Most compasses have an adjustable declination scale. When you set the scale to the local declination, the orienting arrow under the dial will move a few degrees off of straight north. After that, when you align the needle with the orienting arrow, your azimuth readings will be in relation to true north.

Caption: A compass with an adjustable scale.

Setting declination for compasses without adjustable scales

If your compass doesn't have an adjustable scale, you can:

- **Make a scratch at the local declination on the compass dial and fill it in with red ink.**
- **Place a small piece of transparent tape over the local declination on the dial and mark it with a felt tip marker. Put another piece of top on top to keep the mark from rubbing off.**

As you turn your body to align the magnetic needle, align it with your declination mark. Of course, if you know the local declination, you can simply add or subtract it from your compass reading. Subtract eastern declinations from the compass reading; add western declinations to the compass reading.

Narration Script: Other compasses don't have an adjustable declination scale. In that case, you can just mark the declination on your dial with a scratch or a felt tip pen. When you shoot an

azimuth, align the magnetic needle with your declination mark instead of the orienting arrow to get accurate bearings.

The importance of declination

Even in areas with a relatively large declination, the variance from true north is just a few degrees. So why should you be concerned about compensating for it? If you don't adjust for declination when using your compass, your actual course will vary from your intended course. If you're traveling a short distance, the error may not matter. But as you travel longer distances, you'll drift farther from your intended direction. You may even miss your destination entirely.

Narration Script: The difference between true north and magnetic north may not matter over short distances. Over longer distances, your bearing will drift farther from your intended direction.

Comparing true and magnetic north

Here's a simple exercise to help you determine the difference between the azimuths for true north and magnetic north.

There are two versions of the exercise depending on if you have a:

- **Compass with an adjustable declination scale**
- **Compass without an adjustable declination scale**

Read the following to see the procedures for your type of compass.

Compass with Adjustable Declination Scale

If your compass has an adjustable declination scale:

- **Adjust it for local declination—the orienting arrow should line up with the declination on the dial**
- **Turn the dial until the 0/360 degree North mark lines up with the index pointer**
- **While you're holding the compass, turn your body until the red side of the magnetic needle lines up with the orienting arrow**

The magnetic needle is pointing toward magnetic north; the index pointer is pointing toward true north.

Compass without Adjustable Declination Scale
If your compass does not have an adjustable declination scale:

- **Turn the compass dial until the degree marking for your local declination aligns with the index pointer**
- **While you're holding the compass, turn your body until the red side of the magnetic needle lines up with the index pointer**

The magnetic needle is pointing toward magnetic north; the orienting arrow is pointing toward true north.

Navigating with a compass

You can use your compass without a map. A compass can help you hold a straight bearing to a landmark you have spotted visually. Suppose you have sighted a plume of smoke. To reach it, you might have to travel through a forested area where you can't keep an eye on it.

To keep your bearings in this situation:

- **Point the travel arrow toward your destination**
- **Turn the dial until the orienting arrow aligns with the magnetic needle**
- **Follow the travel arrow while keeping the magnetic needle aligned with the orienting arrow**

If you're not using a map oriented to geographic north, you don't have to compensate for declination. You can just set a bearing to your destination in relation to magnetic north.

Narration Script: You can use your compass to get places, whether you have a map or not. Here are the steps to follow if you're not using a map. Point your travel arrow toward a landmark you can see. Turn the dial until the magnetic needle lines up with the orienting arrow. Keep these two aligned as you travel and you'll stay on course. You don't need to adjust for declination because you're not using a map or setting your course in relation to true north.

Orienting the map—adjustable compass

When using a compass together with a map, many compass users find it's helpful to orient a map to true north before plotting a course. When you orient the map properly, you can align the azimuths you shoot from the map with visual landmarks on the ground.

If your compass has an adjustable declination scale:

- **Set the compass to the local declination**
- **Turn the compass dial until north lines up with the index pointer and travel arrow**
- **Place the compass on the map with the travel arrow pointing toward the top (north) of the map**
- **Rotate the map and compass together until the red side of the magnetic needle lines up with the orienting arrow**

Your map is now oriented toward true north.

Narration Script: If you're using a compass AND a map, it's helpful to orient it to true north before you shoot an azimuth. If your compass has an adjustable declination scale, set the compass to the local declination. Then, turn the compass dial until north lines up with the index pointer and travel arrow. Place the compass on the map with the travel arrow pointing toward the top of the map. And finally, rotate map and compass together until the red side of the magnetic

needle lines up with the orienting arrow. After following these steps, your map is now oriented toward true north.

Shooting an azimuth from a map, preliminary steps

After you've oriented your map, you're ready to shoot an azimuth to your destination.

First, plot a straight line on the map from your current location to your destination by:

- **Placing the edge of your compass or a ruler between your current location and your desired destination**
- **Drawing a line connecting those points**

Narration Script: Since you now have your map aligned to true north, you can plot your course and shoot and azimuth from the map. Use a straight edge to draw a line between your starting point and your destination.

Shooting an azimuth from a map, final steps

To find a bearing using your compass and a map, use the line between the starting point and destination following these steps:

- **Place the compass edge along the line you have drawn**
- **Turn the dial until the orienting arrow and orienting lines are parallel to the meridians on the map if your compass is adjusted for declination, or turn the dial until the degree mark for the local declination aligns with the meridians for nonadjustable compasses**
- **Read the bearing at the index pointer to obtain your direction of travel in relation to true north**
- **Determine your back azimuth in case you need to backtrack**

Follow the direction of the travel arrow to your destination. If you're traveling a long distance, take a new bearing periodically to stay on course.

Narration Script: Continue the process we started in the previous section by placing the edge of your compass along the line you drew on the map. Be sure the travel arrow is pointing in the direction of your destination.

Then, turn the dial. If your compass is adjusted for declination, turn until the orienting arrow and orienting lines are parallel with the meridians on the map. If your compass isn't adjusted, turn the dial until the degree mark on the dial for your local declination is pointing to the top of the map.

Finally, check the reading at the index pointer. That's your bearing. Now you are set to follow the travel arrow to your destination.

Calculating distance

To find the distance you have to travel, use the scales on the edges of your compass and follow this process:

- **Choose the scale corresponding to the scale printed on the map**
- **Measure the distance between your starting point and destination in inches or millimeters and measure the same distance on the map scale**
- **Read the equivalent real-world distance from the scale**

Your measurements will give you horizontal distances. If you have to climb up and down on rough terrain, your actual travel distance will be greater.

Narration Script: How far do you have to go? You can use your compass to help answer that question too. Use the scale on the edge of the compass to measure the distance between the two points on your map. Compare that measurement with the printed scale on your map to gauge how far you have to travel.

Calculating walking pace

Once you've calculated how far you need to go, you need some way to know how far you have traveled. If you know your walking pace, you can count your steps to keep track of the distance you've covered.

Here's how to determine your walking pace:

- **Measure a distance of 100 ft. (30 m) on level ground and sloped ground**
- **Walk each distance while counting your steps**
- **Measure a distance of one chain, or 66 ft. (20 m) and repeat the process**

Write down your results. When you measure the distance to a destination on a map, use your walking pace to estimate the number of steps you'll need to take to get there.

Narration Script: It won't do much good to know how far you need to travel if you don't have a way to tell how much ground you've covered. Just do what the pirates of old did when they mapped their buried treasure—pace it off. Count how many steps you need to cover a known distance of 100 feet and one chain. Multiply your walking pace by the distance you have to travel to find how many steps it will take to get there. Then count while you walk.

Global positioning systems (GPS)

The compass can be a hard tool to master. One solution has been brought to the fireline by technological advances. Global positioning systems (GPS) are electronic devices capable of pinpointing a physical location within 10 to 15 ft. (3 to 4.6 m). Some of these systems are handheld, battery-operated devices, and for the lucky ones, GPS units are sometimes built right into your vehicle or ***apparatus*****.**

Here's one thing to consider—while a GPS's battery can die on you, a compass will always have its fix on the magnetic poles, so it pays to learn all navigation instruments.

Narration Script: Global positioning systems—or "GPS" for short—come as battery-powered handheld devices or as built-in automotive units. GPSs use satellite technology to pinpoint the device's location to within 10 to 15 feet. Many GPS units have the additional benefit of being wide area augmentation system capable.

A wide area augmentation system or "WAAS" is a system of satellites and ground stations providing GPS signal corrections to make the receivers more accurate. WAAS corrects for GPS signal errors that can be caused by problems with satellites or by irregularities in the atmosphere.

Caption: An example of a firefighter using a GPS device.

Navigation summary

You've traveled a long way in this topic. You learned some basic techniques for using maps and compasses. These techniques have been used successfully for hundreds of years. They're proven and reliable.

In this topic, we've described:

- **Using maps for pre-incident planning**
- **Types of maps used for wildland fire fighting**
- **Basic map reading skills**
- **Navigating with a map and compass**

Narration Script: You've come to the end of a long journey in this topic on navigation. If you have stayed on course, you learned the basics for using maps and compasses. Your navigation and map reading skills will improve with practice. Get your hands on a good compass and a topo map for an area where you spend a lot of time. Compare what you see on the map with the actual terrain. Practice using your compass whenever you can. It will be time well spent.

Topic 4: Wildland Fire Investigation

Topic introduction

Each time you're called to fight a *fire*, you're on tap to investigate it as well. Because any *wildland fire* could be the result of *arson* or negligence, the actions you take to help preserve the fire scene and protect the evidence it contains may be critical in the apprehension and prosecution of those responsible.

A fire scene provides you with information about where a fire started and what caused it. As a firefighter, you are responsible for helping preserve evidence at the fire scene to determine the fire's *origin* and cause.

Specifically, we'll hone your investigation skills by covering:

- **Items to watch for when traveling to and arriving at the fire scene**
- **Information to record and report**
- **Ways to designate and protect the area of fire origin**

Narration Script: Have you ever wanted to be a detective? Well, you're about to become one. On every wildland incident you engage, you will be expected to look for key evidence pointing to the origin and cause of the fire. It's important work. What you discover could help prevent fires by altering fire fighting protocol, becoming part of fire prevention programs, or leading to civil or even criminal convictions.

Just so there's no confusion, the phrase "fire investigator" actually refers to qualified individuals who have been specifically trained in the investigation discipline. What you'll be doing is aiding the investigator's work—keeping a lookout for valuable clues and evidence. Now, we're going to show you what to watch for and what to do as you gather, preserve, and report that evidence on a wildland incident.

Why determine origin and cause

Your understanding of fire investigation is extremely important. Full-time fire investigators may have trouble reaching the scene because of its remote location. When this happens, you and others on your *crew* might have to perform parts or all of the fire investigation itself before *wind*, wildlife, and foot traffic disturb or contaminate the evidence.

And here are a few excellent reasons why it's necessary to accurately determine a fire's origin and cause:

- **Prosecuting cases of arson and negligence**
- **Using evidence to help recover fire fighting costs**
- **Prioritizing fire prevention programs**

Read the following to investigate the reasons further.

Arson and Negligence

The origin and cause of an incendiary fire may serve as evidence in the prosecution of those responsible for the fire—whether an intentional arsonist or a careless resident. In addition, agencies can make the community aware of particular individuals or vehicles seen in the vicinity of several recent arson fires. The agency or organization can inform residents about what to do if they see these people or vehicles in their neighborhoods.

Recovering Costs

Evidence collected at the fire scene may help fire departments and agencies recover some or all of the costs incurred in fighting the fire. Depending on the size of the fire and the resources required to bring it under control, the outlay of expense can be significant.

Fire Prevention Programs

Origins and causes of fires provide data for an agency's fire prevention programs. For example, if sparks from weed mowers and other lawn equipment start a high percentage of fires in an area, this information can form the basis for a public education or inspection program on spark arrestors.

Narration Script: When you have done all you can to observe the origin and cause of a fire, and to preserve the fire scene itself, you have paved the way for some pretty big "executive decisions" down the road. Look at the reasons why your investigative work is so important.

Observing on the way to a fire

It might seem logical to start investigating a fire once you get to it. Actually, your fire investigation responsibilities begin before you even arrive. You should start observing on your *way to* the incident.

As you travel to the fire scene, pay attention to these conditions:

- **Smoke**
- **People and vehicles**
- **Obstructions**

You will examine each notable factor in turn.

Narration Script: Fire investigation starts after you have the fire controlled and fire ops are over, right? Actually, no. The fire investigation part of your job begins as soon as you are dispatched to a fire. Even on your way to the fire, you will start observing the smoke, people, and vehicles you see leaving the area, as well as any obstructions or conditions that seem unusual.

Smoke

As you approach the fire scene, make a point of asking yourself these questions about the smoke rising from the fire.

- **Is the amount of smoke consistent with other wildland fires in similar *fuels* and weather conditions?**
- **Is the smoke color normal for the types of fuels in the area, or does it suggest someone used an *accelerant*?**

People and vehicles

As you travel to the fire scene, note and record any people or vehicles you observe leaving the area or parked in unlikely spots. Ask yourself these questions:

- **Are any people or vehicles fleeing noticeably faster than others?**
- **Are any people carrying fuel containers or other unusual items?**
- **Are any of the vehicles being driven in the dark without headlights?**

Read the following to see what to look for regarding suspicious persons and vehicles.

People

If you spot suspicious people or activities, try to record as many identifiable features as possible about these people. Report these and any other similar observations to your supervisor:

- **Gender**
- **Age**
- **Height**
- **Weight**
- **Hair color**
- **Race**
- **Clothing**
- **Unusual characteristics**

In addition, note any children leaving the fire area.

Vehicles

If you notice a suspicious vehicle leaving the area, record as many details about the vehicle as possible. Report these and any other similar observations to your supervisor:

- **Color**
- **Make**
- **Model**
- **Age**
- **License plate number**
- **Visible damage**

Narration Script: Get into detective mode as you travel to the fire scene. Make it a point to observe any suspicious people, vehicles, or even children leaving the fire scene. Note the details about those people and vehicles. If possible, write down what you see, and report your observations to your supervisor.

Obstructions

Also take a look at the condition of gates, locks, fences, bridges, and power lines near the scene. Also, abandoned campfires and burning debris are often clues. Ask yourself these questions:

- **Is there evidence of tampering with gates or locks?**
- **Have fences been knocked down or fence wires cut?**
- **Are there tire tracks through downed fences?**
- **Are bridges damaged or destroyed?**
- **Are any power lines down or damaged?**
- **Are there any other unusual conditions that might have been created to impede the crew's response?**
- **Are there any objects that are foreign to the natural or normal surroundings?**

If the answer to any of these questions is "yes," report this information to your supervisor.

Narration Script: Look for any unusual obstacles that might have been intended to slow the crew's fire response. Be aware that some of those unusual items may be hazards to you as well such as downed power lines and damaged bridges.

Knowledge Check 9

Multiple choice—check the box of the answer(s) you choose.

As a firefighter, you are responsible for performing certain investigative functions.

Identify FOUR conditions you should watch for on the way to an incident.

- ☐ **Suspicious badges on law enforcement officers**
- ☐ **Smoke of an abnormal color**
- ☐ **Tire tracks through a downed fence**
- ☐ **Abrupt temperature changes**
- ☐ **Cars driving with headlights off**
- ☐ **Children leaving the scene**

The correct answers are smoke of an abnormal color, tire tracks through a downed fence, children leaving the scene, and cars driving with headlights off.

Determining fire cause

If you are a member of an *initial attack* crew, you will have a better opportunity than anyone to gather information on the fire's origin and cause.

Generally, think of the causes of wildland fires as falling into one of three categories:

- **Natural**
- **Accidental**
- **Intentional**

Read the following to see examples of each category:

- **Natural—A lightning strike or lava flows are examples of a natural-caused fire.**
- **Accidental—Examples of accidental, or negligent, causes are sparks from an exhaust pipe with a faulty or missing spark arrestor and the backfire from a poorly tuned engine. Other accidental causes might include campfires, cigarette butts, matches and candles, trash from dump sites, moving railroad cars, and heavy equipment.**
- **Intentional—Intentionally set fires, also called *unfriendly* fires, range from controlled burns that get out of hand to children playing with matches to arson fires set for profit, revenge, or pyromania. Incendiary fires might include ignition devices such as fusees, two or more fire sets, and persons with histories of starting fires.**

Narration Script: When you arrive at the fire, keep observing. If an investigator is not on the scene, you and the crew should ask yourselves, "Was the fire the result of natural, accidental, or intentional causes?"

Arrival observations

Like most firefighters, you will be eager to attack the fire as soon as you get to it. Don't rush in, or you might miss valuable clues.

Be especially watchful for:

- **People**
- **Tell-tale signs**

Again, be sure to record pertinent information on suspicious people and vehicles, including the time of day and license plate numbers. Report this information to the responding investigator or your supervisor.

Read the following for information on what to observe.

People

Ask yourself these questions about bystanders:

- **Have you seen any of them at other fires?**
- **Do any of them seem unduly excited, emotional, or angry?**
- **Are any of them overly eager to volunteer information or to help fight the fire?**

- **Are any of them having suspicious conversations?**
- **Are any of them quickly leaving the scene in vehicles?**

If the answer to any of these questions is "yes," report these observations to your supervisor or to law enforcement.

Tell-Tale Signs

Watch for these signs indicating a fire's cause or origin:
- **Downed power lines**
- **Objects that are foreign to the natural or normal surroundings**
- **Tire prints or footprints**
- **Signs of a campfire or burning debris**
- **Odd-colored smoke**
- **Types of objects burning**
- **Placement of the fire**

Narration Script: Besides what you noticed as you traveled to the fire, check out any bystanders when you first arrive on the scene. Do any of them look familiar? Have you seen any of them at other fires? Are any of them overly excited or eager to help fight the fire? Report any of these observations to your supervisor or to law enforcement. Also be aware of any signs pointing to the fire's origin, such as footprints or out-of-place foreign objects.

Initial attack observations

When the time finally comes to attack the fire, don't think your observation duties are over. The point of origin is where you may be most likely to find evidence, especially ignition devices.

Note and immediately report any ignition devices you see in the area, such as:
- **Matchbooks**
- **Candles**
- **Road flares or fusees**

It's extremely difficult to accidentally start a wildland fire with a cigarette, but if the number of cigarette butts lining roadsides is any indication, it will happen sooner or later. A lighted match is a different story. After that cigarette is lit and the lighted match tossed into *fine*, dry fuels, a fire can start with ease.

Narration Script: Once you do finally attack the fire, be especially aware of ignition devices, because the point of origin is where you will be most likely to find them. Watch for items such as matchbooks, candles, and road flares or fusees.

Protecting evidence

As if you didn't have enough to think about as you watch for clues and consider the flames, there is one more thing you should do—avoid destroying the evidence. Protecting the point of origin and approaches to it is an important job of the initial attack crew. Often the first *fire suppression* action destroys all possibility of determining the fire's cause and the identity of the suspects.

In the black

Sometimes you'll find evidence of a fire's origin in the *black*, so you must minimize your impact while working or *mopping up* there—especially when you're working near the *heel*. Spraying water, dragging hoselines, using hand tools, driving *apparatus*, and even walking through the fire origin area can destroy evidence. When near the heel, where a fire is usually less intense than in other areas, try working in the *green* if it is safe to do so.

If you must enter the black near the heel, apply your knowledge of *fire behavior* to estimate where the fire might have originated. Protect evidence by covering it and by marking its location with *fireline* tape, flagging, or hand tools. Don't move any evidence unless it's necessary to protect it, and keep others away—if necessary, by posting guards.

Narration Script: Law enforcement often calls the fire department the "evidence elimination squad." Don't let that be true of you. When you work in the black, use extra caution, especially if you are near the heel of the fire.

A basic understanding of fire behavior should tell you any evidence of foul play will be in that area. Dragging hoselines and driving apparatus in the black can destroy evidence. Often, the fire at the heel burns with low intensity. If true in your situation, work from the green instead of the black, but make extra provisions for your safety. Whether you work in the black or from the green, mark the locations of all potential evidence you find.

Knowledge Check 10

Multiple choice—check the box of the answer(s) you choose.

Identify THREE things you can do to protect an area possibly containing evidence.

- ☐ **Place tools around the area**
- ☐ **Mark the area with flares**
- ☐ **Post guards to keep others away**
- ☐ **Apply a light fog stream over the area**
- ☐ **Secure area with flagging**

The correct answers are place tools around the area, post guards to keep others away, and secure area with flagging.

Wildland fire investigation summary

Part of the effort in fighting a fire is solving the riddle behind its cause. While you might be focused on suppression and mop-up, remember to look for clues, preserve evidence, and minimize damage to the scene.

In this topic, you've investigated:

- **Items to watch for when traveling to and arriving at the fire scene**
- **Information to record and report**
- **Ways to designate and protect the area of fire origin**

All firefighters have a responsibility to prevent future incidents. Performing your investigative chores with diligence can influence the future for the better.

Narration Script: As a firefighter, you will be expected to aid the fire investigation process by performing your own investigative duties. To influence the best possible outcome, know what to watch for when traveling to and arriving at the scene of the incident. Know the kind of information you should record, and know how to protect the area of fire origin. Helping to solve the riddle behind a fire's cause is one of the most important things you will ever do.

Topic 5: Cultural Resources

Cultural resources introduction

Fire managers develop programs to protect lives, property, and natural resources. You can add another valuable asset to the wildland firefighter's agenda—the protection and conservation of historic and cultural sites.

In this topic, we'll discuss how your *fire suppression* **actions can affect such cultural resources, and we'll describe methods for protecting them.**

Narration Script: Wildland fires often threaten valuable and irreplaceable parts of our country's heritage. Public lands are home to sites where artifacts of our nation's history and the history of North American civilizations are preserved. Fires and fire suppression activities can damage or destroy these sites.

Foundations for cultural resource preservation

In this topic, you'll have a chance to learn how you'll use fire suppression techniques to protect and preserve cultural resources. First, however, let's look at the foundations of cultural resource preservation practices including:

- **Definitions and terminology**
- **Historical overview**
- **Legal responsibilities**

You will examine each of these items in turn to get further "cultured."

Definition of cultural resource

A cultural resource is any surviving material serving as a potential resource for understanding the past and having significance for inclusion in the National Record of Historic Places (NRHP).

Generally, on public lands and on Native American reservations, the buildings, sites, areas, architecture, memorials, and objects having scientific, historic, religious, or social values compose a non-renewable cultural resource.

In layman's terms, unlike a forest or grassland—once a piece of history is destroyed, it won't grow back. Any information the object provided or personal meaning behind the resource is lost forever.

Narration Script: Cultural resources are the irreplaceable remnants of the history of our nation and the civilizations of the North American continent. If they're damaged, displaced, or destroyed, their ability to reveal the past is lost forever.

Terminology

You need to know a few key terms describing cultural resources:

- **Artifact—An *artifact* is any object made or modified by humans that can be moved or displaced by firefighters or fire suppression actions. Artifacts are characteristic of an earlier time or cultural stage—such as objects found at archaeological excavations.**
- **Feature—A *feature* is a non-portable object such as a rock alignment or post mold. Ancient drawings on large rocks or rock faces are an example of a feature.**
- **Site—A *site* is an area once occupied by humans or used for another specific purpose. Examples include habitation sites, quarry sites, gathering sites, and trails.**
- **Context—A *context* refers to the locations and relationships of artifacts and features within a site. Context helps researchers better understand the meaning of artifacts and what they reveal about the past. When artifacts are displaced, the opportunity to learn from their context is lost.**

Narration Script: A cultural resource can be as large as an entire tract of land holding historical significance, or it can be something as small as a shard of pottery or fragment of iron. Whenever you're working in an area of known historical or cultural significance, keep in mind that even tiny objects can hold enormous value.

Knowledge Check 11

Matching—select the match you choose from the pull down list.

There are many different types of cultural resources. Determine whether each of the items below qualifies as a cultural resource.

Match each cultural resource to the corresponding description. You may use a resource more than once.

Artifact	Pottery shards near an ancient fire pit
Feature	Pottery shards near an ancient fire pit
Site	Pottery shards near an ancient fire pit
Not a cultural resource	Pottery shards near an ancient fire pit
Not a cultural resource	Pottery shards near an ancient fire pit

The correct matches are as follows:
Artifact: Pottery shards near an ancient fire pit
Feature: Carvings and paintings on a boulder
Site: Hilltop used for religious ceremonies
Not a cultural resource: Vegetation covering stone dwellings
Not a cultural resource: Stand of trees near a campsite

Historical overview

Cultural resource preservation has a short history in wildland fire fighting. Careful consideration of the effects of fire management activities on cultural resources emerged

only within the last 20 years. The Pacific Southwest Forest Fire Laboratory monitors the effects of wildfire and prescribed fire on soils and archaeological sites.

Fires **establishing the importance of protecting cultural resources from the impacts of fire management activities include:**

- **Mesa Verde Little Moccasin Canyon Fire, 1972**
- **Custer Battlefield National Monument Fire, 1983**
- **Bandelier National Monument La Mesa Fire, 1977**

Read the following for a description of each fire's effect on a historic resource.

Little Moccasin Canyon Fire, 1972

The 1972 Little Moccasin Canyon Fire in Colorado's Mesa Verde National Park burned more than 1,000 acres (400 ha). Ancient masonry pueblos and ceramic artifacts were damaged, destroyed, or displaced. This fire made it clear that resource management planning techniques didn't adequately address the damage that can result from catastrophic fire or the efforts to suppress it.

Custer Battlefield National Monument Fire, 1983

In 1983, a fire at the Custer Battlefield National Monument burned 800 acres (320 ha). In this case, suppression activities were responsible for more damage than the fire itself. A truck trying to escape the fire's head jarred a headstone loose. Several other headstones were discolored by suppression efforts. However, there was some good news. The fire uncovered new artifacts, including the remains of soldiers who died there. The battlefield monument was created expressly to preserve these resources.

Bandelier National Monument La Mesa Fire, 1977

The La Mesa Fire at the Bandelier National Monument in 1977 burned 15,000 acres (6,000 ha). This fire affected several cultural sites containing artifacts dating back nearly 1,000 years. For the first time, archaeologists assisted fire suppression personnel as line locators. Many sites were saved as a result.

Narration Script: Fire agencies improve their knowledge about cultural resource preservation through difficult experiences. Several major fires changed the way fire agencies approach cultural resource preservation.

Legal responsibilities

Over the years, cultural resources have been lost to the *wildland/urban interface***, indiscriminate digging, vandalism, and commercial exploitation.**

Two laws directly affecting wildland firefighters have been enacted by the U.S. Congress in an effort to protect historical and cultural resources on pubic lands:

- **National Historic Preservation Act (NHPA) of 1966—directs Federal agencies to inventory, evaluate, and protect significant cultural resources under their jurisdictions**
- **Archaeological Resources Protection Act (ARPA) of 1979—prohibits the unauthorized excavation or removal of any archaeological resources from Federal land and strengthens civil and criminal penalties for illegal excavation or collection of artifacts even if the site is not found to be significant**

Narration Script: Cultural resources on public land are protected by U.S. Federal law. The law directs Federal agencies to inventory cultural resources in their jurisdictions. Unauthorized digging or removal of artifacts is a federal crime.

Effects of fire management activities

Fire management activities can have both positive and negative effects on cultural resources.

The positives:

- **Fires and fire suppression activities sometimes clear away vegetation so new areas of a site can be surveyed**
- **Previously unknown artifacts and sites may be discovered**

The negatives:

- **Destruction of architecture and associated information from fire suppression activity**
- **Displacement of artifacts by altering the context of artifacts**
- **Destruction of artifacts**

Narration Script: Sometimes, fires and fire suppression activities can actually help preserve cultural resources. Removing vegetation or cutting firelines may reveal sites and artifacts that have been hidden for years. The negative effects of fire suppression activities are severe and irreversible. These activities destroy architecture and artifacts or displace artifacts from their proper context.

Effects of fireline construction

While fireline construction is intended to protect sites from an advancing fire, a carelessly placed or constructed fireline can cause significant damage by:

- *Dozer* **blades and tracks cutting deep into the soil, destroying architecture, and displacing artifacts**
- **Night operations with heavy machinery unwittingly crushing structures and unseen surface artifacts**
- **Engines,** *water tenders***, and vehicles accidentally crushing cultural material while driving to the** *fireline*
- **Water pressure eroding sites or chipping away the integrity of structures and displacing artifacts**

Using foam is one way to minimize the impact to a historically significant site. We'll get into more cautionary details later in this topic.

Narration Script: Firelines can cause significant damage to cultural resources. They require heavy equipment to carve out a defense against the advance of a fire. The tracks of a dozer or the wheels of an engine can crush artifacts. A dozer's blade scrapes up and displaces everything in its path.

Handline and helispot construction

Like the construction of firelines, building *handlines* **and** *helispots* **involves removing vegetation and scraping or leveling the soil. These fire management actions:**

- **Expose subsurface deposits and load structural sites with discarded vegetation**
- **Cause displacement or destruction of artifacts**

Narration Script: Though cutting line by hand and helispots don't disturb as much territory as cutting a fireline with heavy equipment, both can destroy artifacts and scar sites.

Aerial applications

Aerial applications, or *airdrops,* **are another useful tool for wildland fire management. However, airdrops can cause serious damage to cultural resources. Careful consideration must be given during air operations in and around cultural resource sites.**

Potential damage from air ops includes:

- **Damage from** *retardant* **on structure walls could cause corrosion and contamination of subsurface and surface materials**
- **High velocity retardant hitting structures and causing structural damage**

Narration Script: Fire retardant chemicals can cause damage when they come into contact with structures. When those chemicals are dropped from an aircraft, they're traveling at high speed as they hit the ground. The force of an aerial application can cause as much damage as the chemicals themselves.

Concentration of people

Moving personnel to an *incident* **can look like a mobilization for war—bringing trucks communication equipment, and sometimes establishing massive base camps.**

This unusually heavy traffic to cultural resource sites can pose risks, such as:

- **Trampling patterns and new pathways along firelines and other non-path areas**
- **Forming "new" path areas displaces artifacts horizontally by scattering them over a wide area and it can also displace them vertically by pressing them deeper into the soil or uncovering them**

- **Theft of artifacts "just sitting there" by fire suppression personnel succumbing to temptation**

Narration Script: It takes a lot of people to battle a fire. Typically, a high concentration of personnel means some areas get trampled into paths quickly. When that happens, any artifacts in path areas are likely to be displaced. Also, artifacts in plain view may prove too tempting for some people to resist. An arrowhead, a pottery shard, or a musket ball may seem like an insignificant souvenir. However, removing any artifact is against the law. DON'T DO IT.

Mop-up

Once the fire is *contained***, if you're not careful,** *mop-up* **offers still more opportunities to unwittingly damage cultural resources by:**

- **Moving heavy equipment and trucks inside the black, potentially crushing or displacing cultural materials**
- **Dragging hoses across sites causing breakage, artifact displacement, or structural damage to features such as burials, pit houses, and hearths**
- **Digging and tilling the soil, straight stream water application, and digging roots and stump holes creating a risk for artifact displacement or damage to features**

Narration Script: Mop-up creates unique risks to cultural resources. The same activities you use to uncover hotspots or soak embers are the activities most likely to cause damage or displacement of artifacts.

Prescribed fire

Prescribed fires **are designed to avoid any impact on cultural materials. However, prescribed fires sometimes affect features or sites that were previously hidden or unknown.**

The effects of a prescribed burn are similar to the effects of fire suppression activities. Some of these are:

- **Environmental impact of installing control lines**
- **Physical impact of the fire on structures, pottery, stone artifacts, and archaeological sites**
- **Erosion and vandalism from the loss of ground cover**

The positive impacts are the same as those described for fire suppression—so refresh your memory if they've slipped your mind.

Knowledge Check 12

Matching—select the match you choose from the pull down list.

Fire operations affect cultural resources in significant ways.

Match each fire operation with the type of damage it can likely cause.

Aerial operations	Loading structural sites with discarded vegetation
Use of engines and water tenders	Loading structural sites with discarded vegetation
Construction of helispots	Loading structural sites with discarded vegetation
Concentration of personnel	Loading structural sites with discarded vegetation
Mop-up activities	Loading structural sites with discarded vegetation

The correct matches are as follows:
Aerial operations: Retardant damaging structures
Use of engines and water tenders: Crushing of structures and artifacts
Construction of helispots: Loading structural sites with discarded vegetation
Concentration of personnel: Removal of artifacts
Mop-up activities: Digging and tillage of soil

Steps for protecting cultural resources

Fire suppression activities require vigorous action, even when sensitive cultural resource areas are involved. However, there are some basic steps you can take to protect cultural resources during wildfire suppression and prescribed burning activities.

Protection of cultural resources relies on these three practices:

- **Stay informed**
- **Protect sensitive sites**
- **Speak up**

You will examine each practice in turn for a detailed explanation.

Narration Script: By now, it might seem like damage to cultural resources is just unavoidable. In fact, in a fire suppression situation, some damage is inevitable. However, there are steps you can take to minimize damage and save these irreplaceable resources for future generations.

Stay informed

Keep your ears open and stay informed about plans for protecting cultural resources. The crew briefing is a good place to start. Before you enter an area with known cultural resources, make sure you understand the *incident action plan* **(IAP). The IAP should contain clear and specific instructions for suppression activities around cultural values.**

Incident management teams are usually made aware of existing cultural values at risk during the line officer's briefing. In such cases, a resource advisor might be assigned to the

incident. Your *incident commander* **(IC) or supervisor should brief all burn personnel about sites needing special attention and alternatives to ignition patterns and holding activities.**

Narration Script: You don't have to figure out how to defend cultural resources on the fly. Stay informed. There will be a strategy for protecting cultural resources. Make sure you understand the incident action plan and any instructions for fire suppression activities near cultural resource areas. The daily briefing should take the mystery out of what you need to know.

Protect significant or unknown eligibility sites

Once you know the location of sensitive sites—be proactive. Take action to avoid working within significant sites or sites where you're not sure of the historic or cultural status and value.

Follow these guidelines:

- **Don't disturb a site—practice avoidance by protecting the site from the fire**
- **Mark important sites with flagging tape and make them known**
- **Be aware of the penalties of removing artifacts from any site**

Narration Script: You can't damage a site if you stay away from it. On some incidents, a resource specialist may be on site to help. During the crew briefing, they may point out on a map the sites to avoid or protect. Follow the directions of the resource specialist as long as you can do so without jeopardizing safety. Once you know where sensitive sites are located, you may be asked to help mark them with flagging tape or some other means. If you can defend the site from the fire, you'll obviously minimize the damage. Also, make sure you understand the penalties you could face for removing any artifacts from the area.

Speak up

Speak up if you discover relevant information about cultural resources. Report what you've learned to your supervisor or IC so he or she can modify fire suppression plans when necessary. Here are some rules of thumb:

- **If your** *crew* **encounters archaeological sites and materials, inform your supervisor. If possible, make notes of the site for your cultural resource specialist.**
- **If entering a site, leave it undisturbed and send for a cultural resources specialist.**

Narration Script: If what you see in the field doesn't match with what you expected, speak up. If you find sites or materials that you suspect include cultural resources, inform your supervisor or the IC. Whenever possible, leave the site undisturbed and get help from a cultural resources specialist.

Knowledge Check 13

Multiple choice—check the box of the answer(s) you choose.

During a fire operation, you and your crew come across an area that you suspect may be culturally significant. However, the area is not identified in the IAP for the area.

Identify TWO appropriate steps to protect cultural resources in this situation.

- ☐ **Enter the site and investigate further**
- ☐ **Request an aerial application of fire retardant**
- ☐ **Report the site to your supervisor or IC**
- ☐ **No action required—the site is not designated for protection**
- ☐ **Place firelines outside the area to protect the site**

The correct answers are report the site to your supervisor or IC and place firelines outside the area to protect the site.

Topic summary

Cultural resources on public lands belong to us all. When you protect these resources, you're preserving our history for generations to come.

In this topic, we presented information about:

- **The definition of cultural resources**
- **Cultural resources terminology**
- **Effects of fire suppression activities on cultural resources**

The safety of you and your team are paramount to any incident—but with the careful analysis by your IC and supervisor, you can maintain your safety while also providing an invaluable service to the historical record.

Narration Script: Fire management has long been concerned with protecting natural resources, human life, and property. Now you can add another objective to this list. Public lands hold an irreplaceable record of human history. Protection of cultural resources preserves history for future generations.