EnvirNews
Updating environmental issues and activities at Hill Air Force Base, Utah
Fall 2000

INSIDE

Sound waves help geologists "see" underground

Researchers from Rice University, along with scientists from all over the world, recently came to Hill AFB to test an advanced investigative technique known as three-dimensional seismic surveying. This test was conducted at Operable Unit 2, a former chemical disposal pit on the base's northeast side.

3D-Seismic, as it is commonly called, uses sound waves and sensitive listening equipment to generate electronic images of the subsurface.

Sound waves move through just about anything. But the speed at which sound travels depends on what the waves are moving through. Sound waves also reflect (we call them echoes). By listening to an echo and measuring how quickly it returns to the surface, scientists can tell how far the sound wave has traveled and the types of materials it has traveled through.

This technique has long been used by the oil industry to find the best places to drill. But drilling for oil thousands of feet underground is much different than finding an ancient stream channel 50 feet underground. At such a shallow depth, echoes reflect to the surface nearly instantaneously. This requires special equipment. But that's not all. To produce an accurate underground map, lots of data are required.

At Hill, scientists used 600 listening devices, called geophones, to record the echoes. These geophones were laid out in a precise grid across the site.

When the sound source—in this case, a shotgun—is fired into the ground, a sharp sound wave begins to travel deep into the ground. As it passes through solid materials, echoes are reflected back to the surface. Each of these echoes is detected and recorded by the geophones.

Since each geophone is a slightly different distance from the sound source, each one records a slightly different echo pattern. All 600 patterns are fed into the computer and stored. This process was repeated 1,200 times, with each shot fired at a different location. This produced 720,000 echo patterns for scientists and computers to analyze. Eventually, the researchers will produce a detailed map of the underground channel Hill scientists are looking for.

Researchers from Rice University use a shotgun to send sound waves through the soil. Sensitive listening equipment placed in a grid all over the site will receive and record the echoes. The data will be used to develop a map of the different layers of soil underground.

According to Dr. Jon Ginn, who managed this research project for the Air Force, this map will provide valuable data that will help them clean up the solvents pooled in this underground channel.

"To remove the solvent we have to find where it has pooled," Ginn said. "We have found that the solvent tends to pool in these channels. Accurately mapping the channel here will help us find the best location to place wells or implement new technologies to clean up the solvents."

According to Ginn, accuracy is what it's all about. "With conventional techniques, we can only really get accurate readings to within 50 feet or so. With 3D-Seismic, we can get readings to within a foot."

Ginn expects to have results from the survey in the spring or summer of 2001.

International event

While the survey was conducted by Rice University (Houston, TX), scientists from nine nations from as far away as Uzbekistan participated in the research.

Did you know?

Did you know that sound travels faster through water than through air? It's true. Sound travels through air (at sea level) at a speed of 760 miles per hour. Through water, sound travels at 3,100 miles per hour. Steel is even faster, transmitting sound waves at speed of more than 13,000 miles per hour. Knowing how fast sound travels through different types of rock and clay, is an important part of this research project.

Project funding

This research project was funded by the Department of Energy. Other than a few hours of oversight, Hill did not spend any of its cleanup budget for this work. In fact, Hill has attracted a number of research projects funded by outside sources. In all, more than $12 million worth of research has been conducted at Hill at little or no cost to the base.

Managing runoff

Stormwater collection system prevents floods, creates habitat

When it began to rain on August 30, it poured on Northern Utah. When the skies finally cleared two days later, three inches of rain had fallen at Hill AFB. Similar totals were recorded in nearby communities. It was one for the record books.

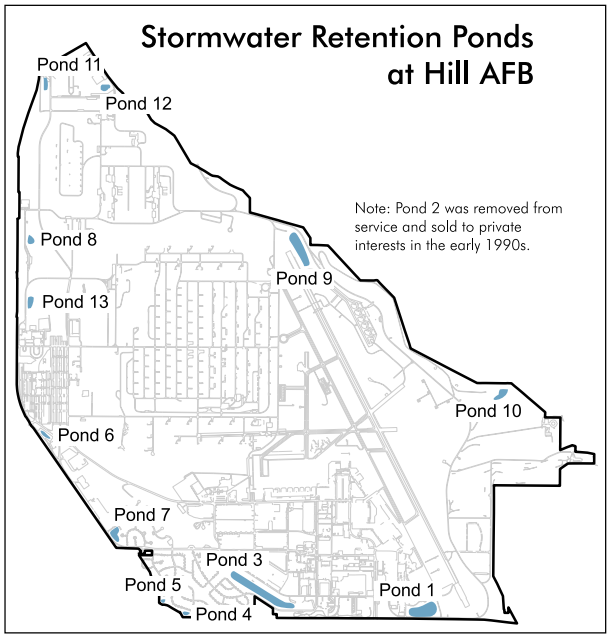
A rain event of this magnitude drops billions of gallons of water from the sky. All this water has to go somewhere. Where it goes depends on where it falls.

Out in rural areas, most of the rain falls on the ground, where it is absorbed by the soil. In developed areas, however, rain falls on streets, driveways, parking lots, rooftops and other areas where it can't be absorbed. The resulting runoff must be controlled, collected and carried away to prevent flooding of homes and businesses.

Like most cities, Hill AFB has an extensive stormwater management system to collect runoff and prevent flooding of the streets, flightline, runway and other base facilities. This network of gutters, drains and underground pipes collects and carries water to one of 12 holding ponds on base. These ponds then slowly release water to the off-base stormwater collection system.

With a good portion of the base's 6,600 acres paved or otherwise covered, the storm of August 30 and 31 caused a tremendous amount of runoff. Fortunately, the base's stormwater management system worked just as it should.

According to Paul Betts, who manages Hill's storm-water collection program, the sheer amount of runoff generated during large rain events could have easily overwhelmed local stormwater systems had the base's system not been there to act as a buffer. This could have potentially caused flooding in local neighborhoods.



"We can control the amount of water released to the local stormwater system," Betts said. "In times of heavy runoff, we can hold everything on base until the off-base system is able to handle it. Then we can release it slowly."

Holding the water on base for a time also helps to improve the quality of the water released into off-base rivers and streams. "By holding the water on base for a few days, it gives nature a chance to work on whatever contaminants were picked up and carried by the water," Betts said. "That means the water being released off-base is much cleaner than if we just discharged it directly."

Pond 3 (left) is the largest of Hill's stormwater ponds and supports a variety of wildlife. Some ponds, such as Pond 9 (above right), don't look like ponds at all and only hold water during periods of heavy rainfall. Pond 11 (below right) is located near the Hill Aerospace Museum. Its lush flora adds aesthetic appeal to the museum grounds.

What's in stormwater?

While it's impossible to list all the things stormwater runoff can contain, it's safe to say that whatever is in the streets is going to get washed into the stormwater. This includes leaking oil and other fluids from cars, litter and other wastes.

At an airport facility (Hill's stormwater discharge is regulated like a commercial airport's), in addition to streets, the runoff from the runway and flightline become a concern. Jet fuel, deicing fluid and other liquids used in flight operations can also be washed away in stormwater runoff.

Where does stormwater end up?

Eventually, all stormwater runoff ends up in the Great Salt Lake. However, to get there, it must be dumped into creeks or rivers. Excessively dirty stormwater can damage the ecosystems of these rivers and creeks. That's why it's important not to dump chemicals or waste liquids into the storm drains or the gutters.

Who regulates stormwater discharges?

The Utah Department of Environmental Quality sets limits and issues permits for stormwater discharges.

CleanUpdate

Cleanup news from the communities surrounding Hill AFB.

West Area
OU-5
OU-9
Sunset, Clinton

Hill AFB has begun a new phase of environmental investigations in two areas of Sunset near the base's West Gate. The purpose of these investigations is to locate contaminated groundwater coming from the base. The primary contaminant found in the groundwater is a degreasing solvent known as trichloroethene (TCE). In 1976, this solvent was removed from general use at the base.

The contamination is not widespread and groundwater samples collected in these areas have shown very low concentrations of contaminants. Since this water is not used for drinking or other household uses, it does not pose a health risk to people living in the area.

Both of these investigations are in their very early stages and are not connected to the area of contamination at OU-5, farther to the north. Much more work will need to be done to determine if these sites will require clean up, and if so, how it will be done. As always, the Utah Department of Environmental Quality (UDEQ) and the U.S. Environmental Protection Agency (EPA) are overseeing the work being done by the Air Force to ensure appropriate actions are taken at the sites.

Additional fieldwork for OU-5 was completed in Sunset and Clinton this past summer to better define the area of the contaminated groundwater in these two cities. An engineering study will be completed early next year to determine if additional early actions should be taken in Sunset and Clinton to clean up this groundwater. Additional information about OU-5, the engineering study, and any proposed early actions will be delivered in the next few months to those residents in Clinton and Sunset who live in the area of the OU-5 plume.

North Area
OU-1
OU-2
OU-4
OU-6
Riverdale, South Weber

Construction of four underground collection trenches at OU-1 was completed in August. When operational in early spring 2001, these trenches will collect groundwater containing solvents and other chemicals that were dumped on base in landfills and chemical disposal pits. This groundwater is currently moving from the base into the community of South Weber. These trenches will collect the contaminated groundwater before it leaves the base.

A full-scale surfactant flood was conducted at OU-2 during February and March 2000. The use of surfactants enabled researchers to remove more than 430 gallons of solvents locked in the soils beneath OU-2. The test took 40 days to complete and was the largest test to date at OU-2. Based on the results of this study, additional full-scale floods will be conducted in adjacent areas of this operable unit during 2001 and 2002.

An engineering firm is studying the slope stability in the area where a trench has been proposed to clean up groundwater contamination at OU-4. The study should provide the Air Force with more detailed information about the use of a trench and its potential effect on slope stability, local structures and infrastructure, including the Davis-Weber Canal. A report from the engineering firm is expected in early 2001.

South Area
OU-8
Layton

Hill AFB will continue to regularly monitor the spring water in a wetland located in an undeveloped wooded area west of Northridge High School in Layton.

Low levels of solvents, primarily TCE, were found previously in the spring water. Because of this, Hill AFB performed a risk assessment to see if this water poses a threat to public health, especially to small children who might play in the water. The risk assessment indicates the water does not pose a threat to public health. Both the EPA and UDEQ concurred with these findings.

Hill AFB has decided, however, to collect water samples at least semiannually from the wetland area and continue to test them for contaminants. If concentration levels of the solvents increase sharply, further actions will be taken. The site will also be re-evaluated next year as part of OU-8's Baseline Risk Assessment, a comprehensive look at the effect of OU-8 on human health and the environment.

If you have any questions, or would like more information regarding the cleanup work at Hill AFB, please contact one of the people listed here.

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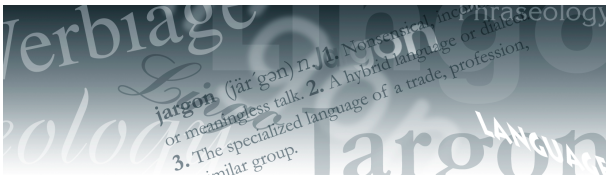
Cutting through the *technospeak*



One of the most challenging tasks for scientists is communicating effectively with non-scientists. There's a simple reason for this: scientists speak a different language.

Okay, technically they still speak English, but the words they use aren't in the vocabulary of the average American. So in many ways, it sounds like a foreign language to most people.

Technospeak, as it is sometimes called, is even difficult for the scientists to keep track of. So to make it easier for them to read and write, they substitute large, complicated words and phrases with acronyms. Acronyms may work for the scientists, but they seem to confuse just about everyone else.

At Hill AFB, we are working with our scientists to help them to use less technospeak and more plain English when dealing with the public. However, you can still expect to see a few technical terms and acronyms pop up here and there.

The purpose of this article is to help you learn a little of the lingo, so when you talk with our scientists, you can still understand them when a little of the technospeak slips out.

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Air stripper: A cleanup system that removes contaminants from water by blowing air through the water. The air captures contaminant vapors and carries them out of the water. Air strippers are most effective on contaminants that evaporate easily.

CERCLA: An acronym for the Comprehensive Environmental Response, Compensation and Liability Act. This is the law that first authorized Superfund. Hill AFB's cleanup program follows CERCLA guidelines.

Exposure pathway: This is the way someone could be exposed to a chemical. Common exposure pathways are eating, drinking, touching, breathing and absorbing the chemical into the skin. A completed exposure pathway means there is a complete path from where the chemical is located.

Groundwater: Probably better named underground water. Groundwater is found beneath the surface in geologic formations called aquifers. Shallow groundwater is the groundwater closest to the surface and is usually not used as a drinking water source. Deep groundwater is separated from the surface by layers of clay or rock and is a source of drinking water.

Direct Push/Hydropunch/CPT: A method of taking a groundwater sample without drilling a monitoring well. Samples are taken by pushing a steel rod into the ground until it reaches the groundwater. Water is allowed to flow into a special tip. The sample is brought to the surface and analyzed. This method is used to help geologists know where to place permanent monitoring wells.

MCL/Drinking water standard: Also called the Maximum Contaminant Level, or MCL, these standards set limits for how much of a chemical is allowed in drinking water. The standards are based on the risk posed to human health by a particular chemical.

Monitoring well: These wells are not used for removing groundwater, but for taking samples of the groundwater. From these samples, scientists can learn what contaminants are in the groundwater and at what concentrations. Monitoring wells are an essential part of Hill's cleanup program.

Natural attenuation: Allowing natural processes to destroy chemicals.

Operable Unit (OU): The technical designation of a distinct cleanup site. Each OU focuses on a particular area of contamination and progresses toward cleanup at its own rate.

Part per billion: One part in a billion parts. Expressed as a percentage, 1 ppb is 0.0000001 percent.

Pump-and-treat: A cleanup technique that pumps water out of the ground and removes the chemicals from the water with some kind of treatment process..

Remedial Action: A cleanup action.

Risk Assessment: A scientific study to estimate the risk the contamination at a particular site poses to people and the environment.

Sampling: Taking a representative portion of a particular substance (soil, water, air) and analyzing it to determine its contents.

Soil boring: A hole dug into the ground, from which soils samples at different depths are taken. Geologists use soil borings to see a representation of the layers of soil and rock underground.

Trichloroethene or TCE. A common degreasing solvent used at Hill AFB until the mid-1970s. TCE is the most common chemical contaminant found in the groundwater at and around Hill AFB.

Volatile Organic Compound (VOC): A chemical that quickly evaporates when exposed to air. Most solvents, including TCE, are VOCs.

Acronyms

An acronym is a word made from parts of other words. Most acronyms are familiar only to those who work with them. Others, though, have emerged from the obscurity of jargon to mainstream language. For example, the word *radar* was originally an acronym of its technical name: RAdio Detecting And Ranging.

Common Acronyms

Some common non-technical acronyms you may see in EnviroNews are:

AFB: Air Force Base

ALC: Air Logistics Center

AFMC: Air Force Materiel Command

DOD: Department of Defense

EPA: Environmental Protection Agency

UDEQ: Utah Department of Environmental Quality

RAB: Restoration Advisory Board

Where to go for help

If you find a term or acronym that stumps you, try our website. Log on to www.em.hill.af.mil/terms, for a more complete list of terms. If you can't find it there, please give Charles Freeman, our Public Affairs representative, a call. You can reach him at (801) 775-6951.

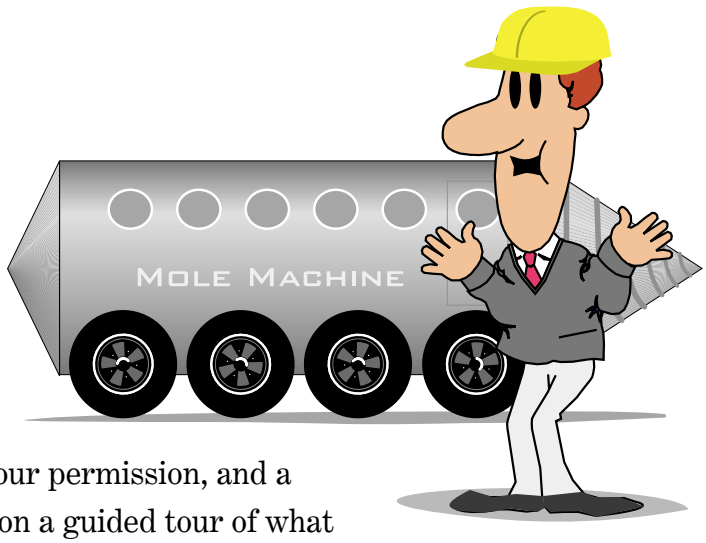
Local recharge
The recharge zone for the deep aquifers in this area is the Wasatch Mountains.

Which way does it flow?
In general, groundwater in this area flows toward the Great Salt Lake, from east to west. There are some exceptions. For example, groundwater in South Weber and Riverdale flows toward the Weber River in a northerly direction.

Don't drink the shallow groundwater
Contamination issues aside, it's generally not a good idea to drink the shallow groundwater. Because there is nothing protecting it from the surface, anything dumped or poured on the ground can find its way into the shallow aquifer. This includes litter, pesticides, animal wastes, and a number of other biological contaminants. In fact, the Davis County Health Department prohibits use of the shallow aquifer for drinking water.

Exposure concerns
If you think you might be exposed to contaminated shallow groundwater, please contact Bob Elliott at the base at (801) 775-3647 to arrange to have your water tested.

Going deep in search of groundwater



Unless you're a geologist, you've probably never thought much about the ground beneath your feet. With your permission, and a little imagination, I'd like to take you on a guided tour of what we call the subsurface. The primary purpose of this tour is to teach you about groundwater—what it is, where it's found and how it moves. So climb in to my imaginary Mole Machine, strap in and enjoy the ride.

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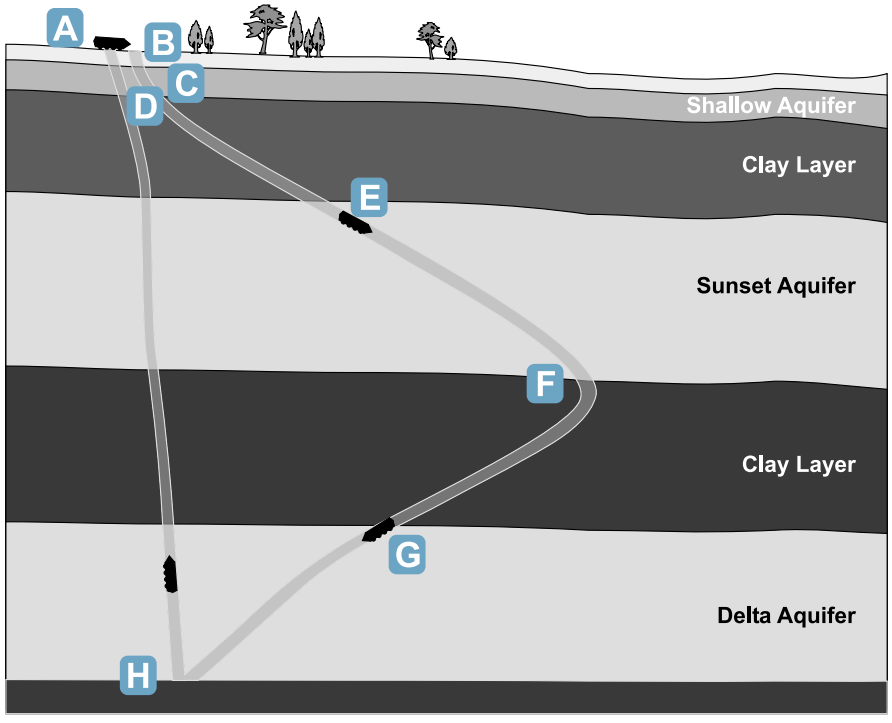
A **The surface.** Our tour begins at the surface. This is where the subsurface meets the atmosphere. And air is the key to being on or above the surface. If something needs a lot of air to survive, it must live at or near the surface, because there simply isn't a lot of air underground. Something else abundant on the surface is water. Water is found in both the air (humidity measures the water in the air) and on the ground (as rivers, lakes, oceans and ice) In fact, 99.4 percent of the water on earth is found above ground. But it's that 0.6 percent that we're interested in, so let's go find some.

B **Depth: 5 ft.** As we enter the ground, you notice it immediately gets very dark. The soil around us is relatively dry for the first few feet. But very soon we will encounter our first groundwater when we reach the water table.

Following the Mole Machine

This map follows the path of the Mole Machine as it moves through the subsurface.



C **Depth: 15 ft.** We have now reached the water table. This first layer of groundwater is called shallow groundwater. This water is not anything like surface water. In fact, it's a mixture of water and soil. The water fills in the tiny gaps between the soil particles. There are no underground rivers here, but the water does flow, just much slower. That's because the water must work its way through the soil particles. The rate at which groundwater flows depends mainly on two factors: the *gradient* of the aquifer and its *per-*

Continued on Page 6

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Going deep (continued from Page 5)

meability. Simply said, the gradient is the slope of the aquifer. Permeability measures how easily water moves through a particular material. For example, water moves easily through a material like gravel, which is said to be highly permeable. On the other hand, water hardly moves at all through clay, which has very low permeability. Water moves fastest through a highly permeable material with a steep gradient and slowest through a low-permeabilty material with no gradient.

The depth of the water table will vary depending on where you are. At some places near the base, the water table is just a few feet from the surface, while in other places, the water table may be 100 feet beneath the surface.

Something else of note: All that stands between the water table and the surface is a few feet of dirt. This means anything dumped on the surface stands a very good chance of reaching the water table and contaminating the groundwater.

D **Depth: 35 ft.** We have encountered some extremely dense clay that will slow our going for a while. The clay is so dense that water hardly moves through it at all. This clay layer is called an *aquitard*, and prevents water from the shallow aquifer from going any deeper. It also prevents any contaminants from the shallow aquifer from going any deeper.

E **Depth: 480 ft.** We have finally made it through the clay layer and have found ourselves in a mixture of sands and gravels, but still saturated with water. We are now in what is called a *deep aquifer*, in this case, the Sunset Aquifer. The water in this aquifer probably originated up in the mountains and eventually worked its way into this aquifer. Because groundwater moves so slowly (only a few feet per year), the water in this aquifer could be decades old.

Ahead is a drinking water supply well. There are a number of these wells drawing water from this aquifer. Since it is protected from the surface by the clay layers above, the water isn't likely to be contaminated.

F **Depth: 595 ft.** We have reached the bottom of the Sunset Aquifer and are entering another clay layer. When we emerge from the clay on the other side, we will enter the Delta Aquifer, another deep aquifer.

G **Depth: 715 ft.** We are now in the Delta Aquifer. Like the Sunset Aquifer, this is also an excellent source of drinking water. Water in this aquifer is older than the water in the aquifer above, because it has probably traveled much farther to get here.

H **Depth: 950 ft.** We are now at the bottom of the Delta Aquifer and have reached yet another clay layer. We could continue to go deeper, but we will only find more of the same types of formations.

As we ascend back to the surface, it's hard not to notice the number of layers of different types of materials we pass through. In fact, geologists have identified nearly 30 distinct layers between the surface and the bottom of the Delta Aquifer.

Geology is not a simple science. Variations exist in every formation and even the best geologic maps and cross-sections are estimates. And since there aren't any real Mole Machines, it's not likely to change anytime soon.

Come visit us on the web!

Find out more about Hill AFB's environmental programs by logging on to

www.em.hill.af.mil

EnviroNews

EnviroNews is a quarterly publication of the Environmental Management Directorate, Hill AFB, Utah, designed to inform the public of hazardous waste cleanup and other environmental activities at Hill AFB.

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