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Nature's ground troops

Navy drafts bacteria to battle contamination at Yorktown Naval Weapons Station

Yorktown Naval Weapons Station

By Jeff Long
Daily Press

YORKTOWN

People who have never been



Daramend is the trade name



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YORKTOWN

People who have never been inside the guarded gates of the Yorktown Naval Weapons Station might not realize how much it's like a nature preserve.

And how much it's not.

A bald eagle makes its home within the boundaries of the 12,213-acre station, which straddles Newport News and the counties of York and James City. Foxes and wild turkeys abound. About 12 osprey nests are scattered about.

On a recent morning, with snow crunching underfoot, three white-tailed deer bounded up a tree-studded slope across the pond from where Jeffrey C. Harlow stood.

"They're all over," Harlow said, as the deer disappeared beyond a ridge.

"The biggest hazard here," he quipped, "is ticks and chiggers and Lyme disease."

But that's not really true, and Harlow knows it better than anyone. He's an environmental engineer



Kenneth D. Lyons/Daily Press

Daramend is the trade name for a fertilizer made from natural plant fibers. It stimulates growth of the bacteria already in the soil, so the bacteria can break down contaminants, such as TNT, faster.

of war and peace, the station's mission has been mostly at odds with nature. Concern for the environment has not always gone hand-in-hand with mixing the ingredients for bombs.

That's changing. Slowly.

In 1992, the Environmental Protection Agency put the station on its National Priorities List — making it the military equivalent of a Superfund site. The list identifies places where there is a release of hazardous substances. It informs the public about sites

to public health and the environment.

So far, taxpayers have spent \$22 million cleaning up 21 hazardous sites at the weapons station — removing such things as batteries, drums, residual ash from explosives and other materials, inert torpedoes, missiles, 500-pound and 1,000-pound bombs, mine hardware and abandoned underground storage tanks.

That work has helped eliminate "imminent and substantial

■ Bacteria

Continued from A1

threats," according to Environmental Protection Agency documents. For its efforts, the weapons station has been nominated by the Navy for the secretary of defense's Environmental Security Award.

There's still a lot more to be done, however. It's estimated another \$31 million is needed to clean the station's remaining hazardous sites. Harlow, who is in charge of such projects at the station, wants them cleaned up by 2007.

As he watched the deer scamper from view, Harlow said the soil beneath the pond and in the marsh beyond represents the station's worst environmental problem — and its most innovative solution.

"Site 6," it's called. The formal name is the "Explosives-Contaminated Wastewater Impoundment."

For years, in the now-deserted building behind Harlow, workers steam-cleaned bombs that were either defective or obsolete. They collected the explosive TNT from inside the bombs, to be re-used in other bombs.

The job began in 1942, during World War II, and continued through the Korean and Vietnam wars. It ended in 1975.

The wastewater from the process got pumped into the marsh in back of the building. Along with it went remnants of TNT and a chlorinated solvent called trichloroethylene, or TCE, which had helped clean the used bomb-casings.

By the time people paused to wonder what kind of environmental damage that stuff did, puddles of water at the site had turned blood-red — a telltale sign that all was not right in these seemingly serene woods.

The concentration of TNT in the soil had grown to 11,350 parts per million. The Environmental Protection Agency set the safe level at 30 parts per million for the site.

People exposed to TNT can suffer from anemia, abnormal liver function, skin irritation and cataracts. Animals that ate or breathed TNT, according to researchers, suffered from similar blood and liver effects, as well as spleen enlargement and other problems with the immune system.

TCE, meanwhile, can break down into dangerous substances, such as vinyl chloride and 1,2-dichloroethene — possible carcinogens.

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Harlow, a civilian employee, is the "Installation Restoration Program coordinator at the Naval Weapons Station. He and others are trying to bring the level of TNT-contaminated soil down to just 15 parts per million. Working on the cleanup with the station are the Naval Facilities Engineering Command, the Virginia Department of Environmental Quality and the Environmental Protection Agency Region III.

Harlow said people aren't likely to be exposed to the contamination because the TNT and solvents haven't leaked off the grounds of the weapons station. The site itself is in a restricted area, so few people from the station get near enough for long enough to be affected.

The wetlands at the site keep the TNT contained, Harlow explained. That's what wetlands do, he said, and why they're so important to protect.

"They're essentially nature's filter," Harlow said. "Or, I was going to say, nature's septic tank."

Deer and other wildlife, however, pay little attention to "restricted area" signs. The contamination's threat is mainly to the animals that call the woods home.

To clean up the contamination, Harlow's team is using a technique that's rarely been tried on TNT before, although it has become a common enough method of cleaning up such things as oil.

The technical name for the process is "bioremediation."

In laymen's terms, bacteria are eating the TNT and solvents — which, it turns out, are better food for bacteria than for deer and foxes and osprey.

Microbes are really adaptable. They break down, or "eat," the stuff that's in the soil where they live — even if that stuff is a powerful explosive, or deadly solvent.

The microbes don't "eat" all of the TNT. They break it down, degrading it until it's no longer harmful — chemically altering its structure. First, the microbes go after oxygen molecules on the TNT. Then they can get at the carbon molecules.

The former TNT becomes "soil humic material."

In other words, dirt.

Think of the process as peeling a banana to eat the fruit, but leaving

the skin. What remains isn't a banana anymore.

All of which would happen naturally — over hundreds of years.

Given that much time, the native microbes in the soil behind the abandoned building would break down the contaminants right there in the marsh. Or, at least in some places, where conditions are just right.

The Navy and its partner in the project, Grace Bioremediation Technologies, are just speeding up what the microbes would do on their own. And making the conditions right for all of the contamination to be broken down as small as possible, until it's no longer harmful.

Grace is covering half the cost of the process, hoping it will prove effective enough to use elsewhere.

"We wanted to demonstrate it, full-scale, for the military," said Robert J. Ferguson, senior project manager at Grace.

"Potentially, this will be a lucrative market for them," Harlow said.

The Toronto company has already used the technique at military bases to clean up such things as petroleum and chemicals used to treat wood.

So far, the results at the Yorktown Naval Weapons Station have proved promising. The microbes have reduced the levels of TNT in the soil from 11,350 parts per million to about 100 parts per million, according to the most recent readings.

To do that, the bacteria have to be nurtured — encouraged to do quicker what they do naturally. In a way, it's like building a compost heap in

your back yard.

"You're putting them in an atmosphere to induce their growth," Harlow said, "and allowing them to do it faster. It's an environment where they can be bigger, faster, meaner. Instead of taking years in the marsh, it's taking a few months to do it."

"We take that process that works in nature and multiply it many, many times," said Ferguson.

That's done within a 700 foot long greenhouse that's 30 feet wide. It's about half a mile from the contaminated site.

Inside, it smells kind of like a barnyard. The temperature is in the mid-70s. It's humid.

"If you got a sunny day, it'll make 95," said Harlow.

That's in the winter. In the sum-

mer, it'll get hotter than 130 deg. Ferguson said the military no different than other orgar tions years ago. Environme problems just weren't the conc they are today.

"It was a different operating cedure," he said. "And they more important concerns."

Such as World War II. Korea. V nam.

"Now, the Navy is taking car things it needs to take care of," I guson said.

"Farmers would love the soil have now," he added. "But ti wouldn't want it the way it starte

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Treating TNT

Here are the steps in the "bioremediation" process being used at the Yorktown Naval Weapons Station to clean up soil contaminated with TNT:

1 October 1998

A biocell, or trench, 700 feet long and 30 feet wide, made of plastic lining, is built about half a mile from the contamination site.

2 February 1999

Excavation and transportation of about 1,200 tons of soil from the contamination site to the biocell. The area excavated is about 80 feet by 160 feet, 4 feet deep.



3 March-April 1999

Greenhouse built over the biocell.

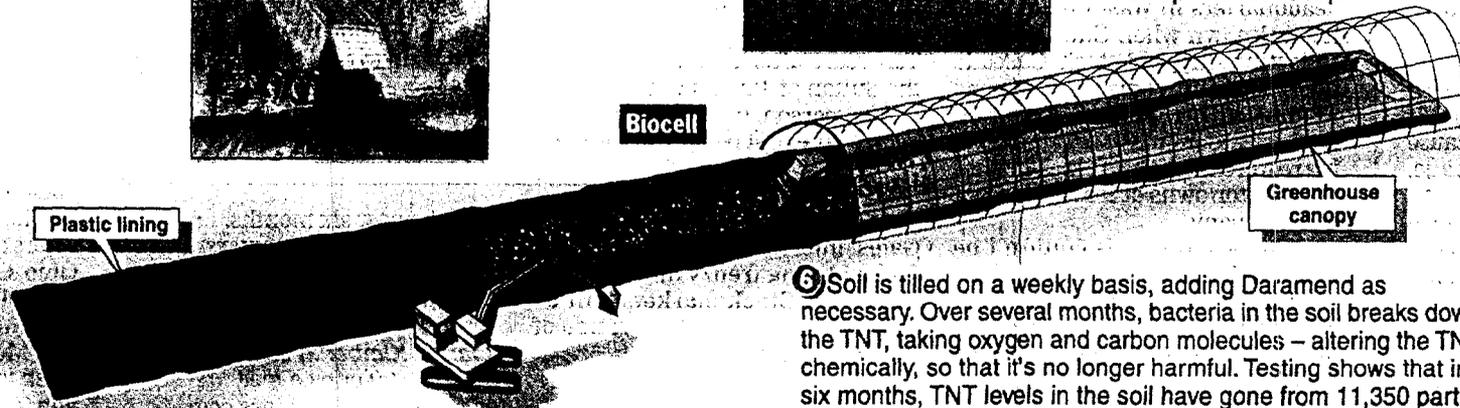
4 May-June 1999

Soil is dried inside the greenhouse.



5 August 1999

Soil is treated with Daramend, a kind of fertilizer for bacteria. It's made of plant fibers and stimulates the growth of bacteria already in the soil. The treatment is done with a tractor, using a tiller that can churn the soil up to 2 feet deep.



6 Soil is tilled on a weekly basis, adding Daramend as necessary. Over several months, bacteria in the soil breaks down the TNT, taking oxygen and carbon molecules — altering the TNT chemically, so that it's no longer harmful. Testing shows that in six months, TNT levels in the soil have gone from 11,350 parts per million to less than 100 parts per million. The goal is to have the concentration down to 15 parts per million by early spring.

Allen Walker/Daily Press

dress EPA proposal to add Cheatham Annex to cleanup list

A public meeting on the reasons for putting the site on the National Priorities List will be held at 6:30 p.m. Wednesday in the Charles E. Brown Park community building, off Old Williamsburg Road (Route 38) near Lackey. The public can comment on whether to include the site on the list until April 4.

Cheatham Annex was commis-

sioned in June 1943 as a satellite unit of the Naval Supply Depot to provide bulk storage facilities. The mission of Cheatham Annex has remained essentially the same since its commissioning.

The primary mission of the annex is receiving, storing, packing and shipping of materials to federal facilities on the East Coast and

About the meeting

What: Public meeting about Cheatham Annex

When: 6:30 p.m. Wednesday

Where: Charles E. Brown Park community building

major distribution centers in Europe.

During World War I, a portion of the current Navy property was the location of a large powder and shell-loading plant operated by DuPont.

The DuPont plant operated for about three years, closing at the end of World War I.

For details about Wednesday's meeting, contact William Hudson at (800) 553-2509 or (215) 814-5532.

About the weapons station

- The Yorktown Naval Weapons Station covers 12,213 acres, primarily in central York County on the York River. Parts of it are also in Newport News and James City County. It now includes the former Naval Supply Center-Cheatham Annex. The Colonial National Historical Park is near the station.
- The York River drainage basin near the station includes wetlands, endangered species and fisheries. The Chesapeake Bay is about 12 miles down the York River from the station.
- The station's primary mission has been to maintain, produce and store ordnance. It has buildings for administration, housing, supply and operational support. The station's population includes 2,427 military and civilian personnel. There are 457 housing units.
- Originally named the U.S. Mine Depot, it was established in 1918 to support the laying of mines in the North Sea during World War I.
- For 20 years after the war, the depot received, reclaimed, stored and issued mines, depth charges and related materials.
- During World War II, it was expanded to include three additional TNT loading plants and new torpedo overhaul facilities.
- A research and development laboratory for experimentation with high explosives was established in 1944.
- In 1947, a quality evaluation laboratory was developed.
- On Aug. 7, 1959, the U.S. Mine Depot was renamed the U.S. Naval Weapons Station.

More about the terms

More about the terms

■ National Priorities List:

Compiled by the Environmental Protection Agency. It identifies places where there is a release of hazardous substances. It informs the public about sites that pose the most significant risk to public health and the environment. The Yorktown Naval Weapons Station has been on the list since 1992.

So far, \$22 million has been spent cleaning up environmental contamination at the station.

Another \$31 million will be spent to finish the job. (Environmental Protection Agency documents.)

■ Bioremediation:

The process by which living organisms act to degrade hazardous organic contaminants or transform hazardous inorganic

contaminants to environmentally safe levels in soils, subsurface materials, water, sludges and residues. (Department of Energy's Natural and Accelerated Bioremediation Research program.)

■ Daramend:

Grace Bioremediation Technologies' trade name for a kind of fertilizer for bacteria, made from natural plant fibers. It stimulates the growth of bacteria already in the soil, so that the bacteria can break down contaminants, such as TNT, faster. (Grace Bioremediation Technologies.)

■ Vinyl chloride:

A colorless, flammable gas at normal temperatures with a mild, sweet odor. It is a manufactured substance that is used to make polyvinyl chloride (PVC). Vinyl chloride also results from the breakdown of other substances, such as trichloroethylene (TCE). Exposure to vinyl chloride occurs mainly in the workplace. Breathing high levels of vinyl chloride for short periods can cause dizziness, sleepiness and unconsciousness, and, at extremely high levels, it can cause death. Breathing vinyl chloride for long periods can result in permanent liver damage, immune reactions, nerve damage and liver cancer. (Agency for Toxic Substances and Disease Registry, of the Department of Health and Human Services.)

■ 1,2-dichloroethene:

A highly flammable, colorless liquid with a sharp, harsh odor. It is used most often in the production of solvents and in chemical mixtures. (Agency for Toxic Substances and Disease Registry.)

■ Mercury:

Heavy metal that can accumulate in the environment and is highly toxic if breathed or swallowed. Heavy metals are metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic and lead); they can damage living things at low concentrations and tend to accumulate in the food chain. (Environmental Protection Agency: "Terms of the Environment.")

■ Organic compounds:

Substances containing mainly carbon, hydrogen, nitrogen and oxygen. (Environmental Protection Agency: "Terms of the Environment.")

The station's most hazardous sites

Navy studies conducted during 1983-89 identified 21 sources of hazardous materials at the Yorktown Naval Weapons Station. In 1992, the Environmental Protection Agency put the weapons station on its National Priorities List.

So far, taxpayers have spent \$22 million cleaning up hazardous sites at the weapons station. It's estimated another \$31 million is needed to clean up the rest.

Listed below are some of the station's most hazardous sites and their status today.

Sites ① and ③

Dudley Road Landfill and Group 16 Magazine Landfill.

■ **Location:** The Dudley Road Landfill is a 6-acre area just north of the headwaters of Indian Field Creek. The Group 16 Magazine Landfill is a 2-acre area just south of that, across a ravine.

■ **Problem:** Dudley Road was a solid waste landfill from 1965 until 1979, with one area used for disposal of plastic lens grinding waste. Other waste included asbestos, oil, grease, paint, solvent containers and household appliances. The Group 16 Magazine Landfill operated from 1940 until 1970, taking such things as solvents, sludge from boiler cleaning, grease-trap waste and animal carcasses.

■ **Status:** Cleanup complete.

■ **Cost:** \$200,000 to study, \$500,000 to fix.

Site ⑥

Explosives-Contaminated Wastewater Impoundment.

■ **Location:** A 3-acre site adjacent to wetlands along a small tributary to the main branch of Felgates Creek.

■ **Problem:** From 1942 until 1975, contaminated wastewater and solvents were released as workers collected the explosive TNT from defective and obsolete bombs.

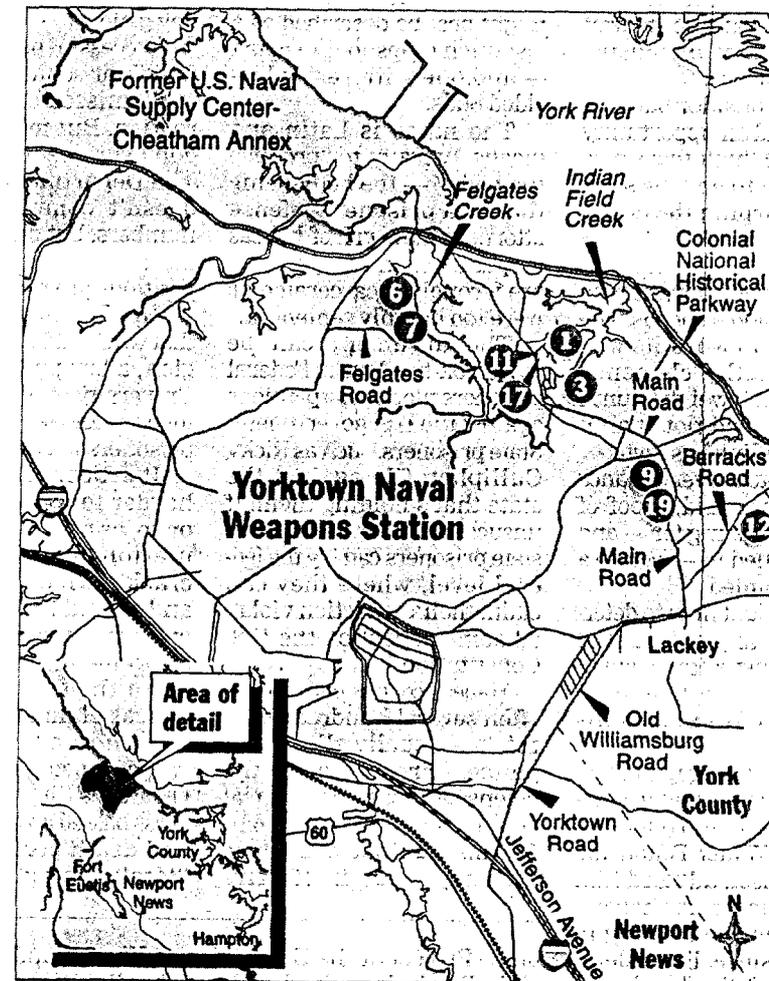
■ **Status:** Cleanup under way.

■ **Cost:** \$300,000 to study, \$600,000 spent on the first phase of cleanup and another \$600,000 available for the second phase. Three or four more phases may follow.

Site ⑦

Plant 3 Explosives-Contaminated Wastewater Discharge Area.

■ **Location:** A 300-foot-long



drainage area adjacent to wetlands and along a small tributary of Felgates Creek.

■ **Problem:** Received nitramine-contaminated wastewater between 1945 and 1975. Nitramine, or tetryl, was used in the manufacture of explosives. Workers who breathed tetryl-laden dust complained of coughs, fatigue, headaches, eye irritation, lack of appetite, nosebleeds, nausea and vomiting, according to the Agency for Toxic Substances and Disease Registry.

■ **Status:** Cleanup complete.

■ **Cost:** \$700,000.

Sites ⑨ and ⑱

Plant 1 Explosives-Contaminated Wastewater Discharge Area and Conveyor Belt Soils at Building 10.

■ **Location:** A 600-foot drainage ditch, just east of Lee Pond, which empties into the eastern branch of Felgates Creek. Site 19, a 500-foot by 10-foot strip of soil, is about 300 feet from Site 9.

■ **Problem:** Soil contaminated with nitramine at both sites.

■ **Status:** Cleanup complete.

■ **Cost:** \$150,000 to study, \$700,000 to fix.

Sites ⑪ and ⑰

Abandoned Explosives Burning and Holm Road Landfill.

■ **Location:** The burning pits are half an acre, south of Dudley R north of a drainage channel lead to Indian Field Creek. The landfill is a 2-acre area, south of Holm R and east of Main Road.

■ **Problem:** The pits were used from 1930 to 1950 for burning ordnance and ordnance-contaminated waste. About 200 pounds of nitramine waste residue may have been deposited. Merc posed health problems for wildlife. The landfill operated from the 1950s to the 1960s, and took such things as acid batteries from underwater weapons, hydraulic fluids and drums from public works and ordnance production shops. Contaminants would pose a cancer risk if the area was ever developed.

■ **Status:** Cleanup to start soon.

■ **Cost:** \$135,000 to study, \$250,000 to fix.

Site ⑫

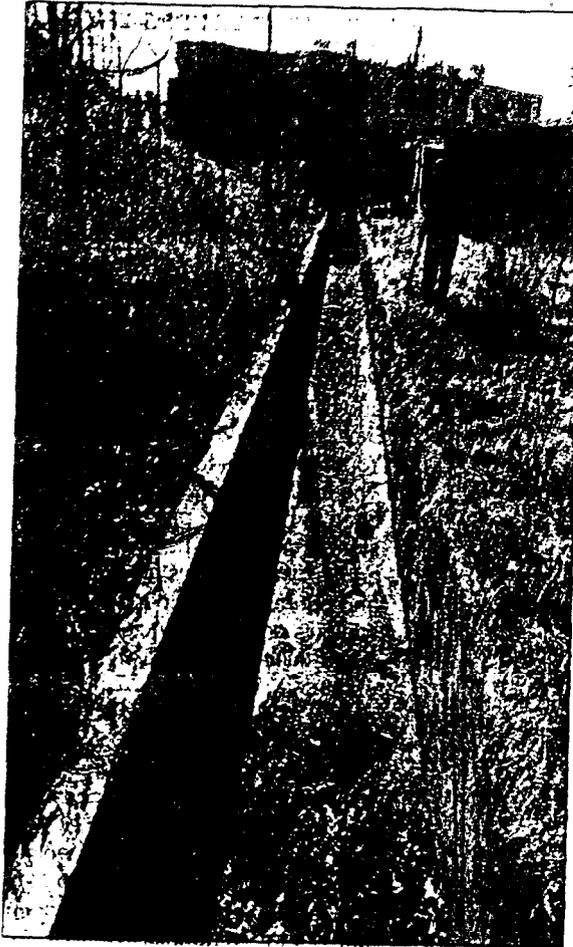
Barracks Road Landfill.

■ **Location:** A 4-acre landfill, east of Barracks Road, north of the community of Lackey.

■ **Problem:** Operated from 1925 to the mid-1960s, receiving 1,400 tons of waste that included refuse, scrub wood and nitramine-contaminated packaging. It's likely that solvents were also deposited.

■ **Status:** Cleanup complete.

■ **Cost:** \$325,000 to study, \$1 million to fix.



Kenneth D. Lyons/Daily Press

A concrete drain leads from a Yorktown Naval Weapons Station building where TNT used to be collected from defective or obsolete bombs. For years, wastewater contaminated with TNT and other hazardous materials flowed down this drain into a marsh.

Powerful TNT is pervasive

By Jeff Long
Daily Press



Kenneth D. Lyons/Daily Press
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The formal name is trinitrotoluene — a pale-yellow, solid, organic nitrogen-compound.

But it's commonly known as TNT. Anyone who has watched a Road Runner cartoon knows TNT is a powerful explosive.

Because TNT melts at 173 degrees Fahrenheit and does not explode below 464 degrees, it can be melted in steam-heated vessels and poured into casings, according to the Encyclopedia Britannica. It's relatively insensitive to shock and cannot be exploded without a detonator.

For these reasons, the encyclopedia notes, it is the most favored chemical explosive, extensively used in munitions and for demolitions.

For years, it has posed one of the worst environmental headaches for the Yorktown Naval Weapons Station. A multimillion dollar cleanup of TNT contamination is under way at the station. The threat is mainly to wildlife at the weapons station, since it's contained to an area away from people.

The following information about TNT comes from the Agency for Toxic Substances and Disease Registry, part of the U.S. Department of Health and Human Services:

It doesn't occur naturally in the environment. The explosive is used in military shells, bombs and grenades, in industrial uses and in underwater blasting. TNT production in the United States occurs solely at military arsenals. Exposure to it occurs through eating, drinking, touching or inhaling contaminated soil, water, food or air.

TNT enters the environment in waste waters and solid wastes resulting from the manufacture of the compound, the processing and destruction of bombs and grenades, and the recycling of explosives. It moves in surface water and through soils to groundwater. In surface water, it is rapidly broken down into other chemical compounds by sunlight. It is broken down more slowly by micro-organisms in water and sediment. Small amounts of it can build up in fish and plants.

Health effects reported in people exposed to TNT include anemia, abnormal liver function, skin irritation and cataracts.

Similar blood and liver effects, as well as spleen enlargement and other harmful effects on the immune system, have been observed in animals that ate or breathed TNT.

Another problem for the environment at the weapons station is a solvent called trichloroethylene, or TCE. It's a colorless liquid that is used as a solvent for cleaning metal parts.

The Agency for Toxic Substances and Disease Registry has the following information about TCE:

Drinking or breathing high levels of it may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma and possibly death. It's used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids and spot removers.

TCE is not thought to occur naturally in the environment. However, it is present in most underground water sources and many surface waters as a result of the manufacture, use and disposal of the chemical.

TCE easily dissolves in water. It quickly evaporates from surface water, so it is commonly found as a vapor in the air. TCE evaporates less easily from the soil, where it may stick to particles and remain for a long time. TCE may stick to particles in water, which will cause it eventually to settle to the bottom sediment. TCE does not build up significantly in plants and animals.

Another problem with TCE, according to experts at the weapons station, is that it can break down into even more dangerous substances, such as vinyl chloride and 1,2-dichloroethene — possible carcinogens.

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