FOCUS on Water

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EDWARD BORN

Vacant house in Poplar Camp

This house *(circled)* in the rural community of Poplar Camp, near the intersection of I-81 and I-77, stands vacant today because in 1978 a truck hauling a crane being used to construct a bridge on I-77 pulled into this service station and ran over a corner of an island *(foreground)* that at the time held gasoline pumps. This minor accident broke a pipe connecting a pump to an underground storage tank. A short time later, a resident living downhill from the station called the Virginia Water Control Board to report that his well water smelled like gasoline.

This was one of 338 incidents of groundwater pollution by a petroleum product reported to the VWCB from 1979 through 1985.

To read Elizabeth B. Crumbley's account of how this incident affected the station owner and four families in Poplar Camp, please turn the page.

For nearly 1.8 million Virginians, groundwater is their source of water. What can they do when it becomes unfit to drink?

by Elizabeth B. Crumbley

IN December 1978, a crane being used to construct a bridge on Interstate 77 in Wythe County drove into a nearby Service Gas station in the community of Poplar Camp to refuel. The crane ran over a corner of a gasoline pump island and cracked the concrete — not a surprising accident for a machine of that size — but did no apparent damage to the pumps.

The service station owner, Service Gas Co. Inc., had recently installed an inventory control system that showed a large loss of gasoline after the accident. A pipe connected to one of the station's underground gasoline storage tanks had been pulled loose when the concrete was broken. Service Gas Co. repaired the piping but did not report the gasoline leak.

In January 1979, Vernon Beasley, one of several local residents whose wells are less than one-half mile downhill from the service station, noticed a gasoline-like odor coming from his well water and called the Virginia Water Control Board's (VWCB) Pollution Response Office.

Beasley and his neighbors are among the nearly 1.8 million Virginians who rely completely on groundwater as the source of water for drinking, cooking, washing, etc. Groundwater is water that collects in pores and rock formations when water from rain, snow, rivers, and streams seeps beneath the ground. Just as rivers and streams flow, groundwater moves through the earth, though far more slowly — often only a few feet a year. Because several large public utilities use groundwater to supply their customers with water, especially during periods when river flows are low, the Virginia Water Control Board has estimated that 8 of every 10 Virginians get part of their drinking water from groundwater.

Elizabeth B. Crumbley is an information director and the editor of Water News.

Staff members in the VWCB's Southwest Regional office initially investigated the wells of Beasley and several of his neighbors who also had begun to notice changes in their water. After comparing water samples from the residences and gasoline samples from the station, the investigators decided that the gas station leak was the source of the well water contamination.

Service Gas Co. turned the matter over to its insurance company, which hired an independent geologist. When the geologist reported that the clay between the gas station and the contaminated wells was impervious and the leak could not have reached the wells, the insurer told the well owners that Service Gas Co. could not be held responsible for the contamination.

Mike Dovel, regional geologist with the VWCB's Southwest Regional Office, was then asked to visit the site and give his opinion as to the source of gasoline found in the contaminated wells. It was his opinion that the rock between the service station and the residential wells largely was composed of cavernous limestone, not impervious clay. His report concurred with the findings of the other VWCB investigators — that the gas station leak was the cause of the groundwater contamination.

Even after additional tests led to the same conclusion, Service Gas Co. continued to deny responsibility for the contamination and refused to initiate a groundwater cleanup program. It was then, about two years after the leak had occurred, that Service was summoned to give testimony before the VWCB Citizen Board, which decides whether or not a case should be turned over to the State Attorney General's Office. The company's insurer claimed during the hearing that there were other possible suspects: an abandoned service station nearby; a recently replaced tank in another nearby station; and several truck wrecks that had occurred on the interstate exchange below the service station site.

The Citizen Board ruled that further tests should be conducted. Under the supervision of Dovel, a drilling contractor made several test borings between the gas station and the affected residential wells. When Dovel discovered the odor of gasoline in the test wells, he injected a dye tracer into one of them; the dye showed up in the residential wells.

"Only twice in more than seven years of investigation have I found a direct source sample match," Dovel said. Gasoline changes its "chemical fingerprint" as it passes through soil and rock. Often, by the time it appears in the water well, a chemical match cannot be made between the gasoline sample and the gasoline in the well.

PREP hotline open round-the-clock

The Virginia Water Control Board's Pollution Response (PREP) Hotline — (804)257-0080 — is open round-the-clock. Dave Chance, director of the PREP office, says the board is concerned with the effects of contamination on aquifers, and that tests are conducted when there is a "reasonable expectation" of contamination. He offers this advice:

- Call the hotline or your regional VWCB office if there is a change of taste, color, or odor in your well water —even if the strange taste goes away for a few days.
- If you are reluctant to make a report, ask your neighbors who have drinking water wells if they have noticed a change in taste, color, or odor.
- Be observant — know about potential sources of contamination nearby. Sole sources of drinking water can be destroyed and homes can be rendered unlivable by groundwater contamination.

ILLUSTRATIONS BY GEORGE V. WILLS

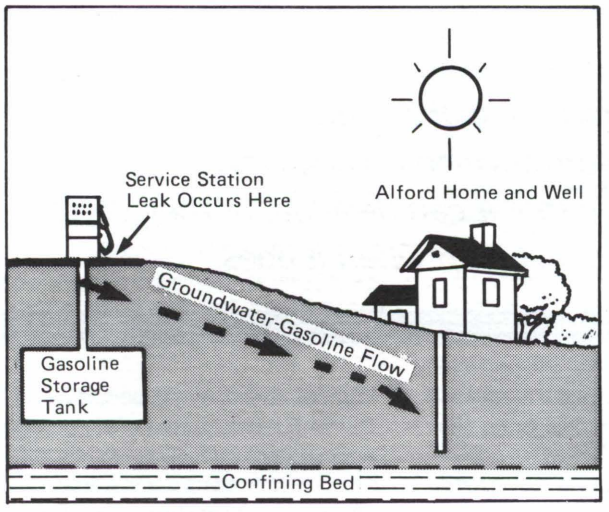

FIGURE A

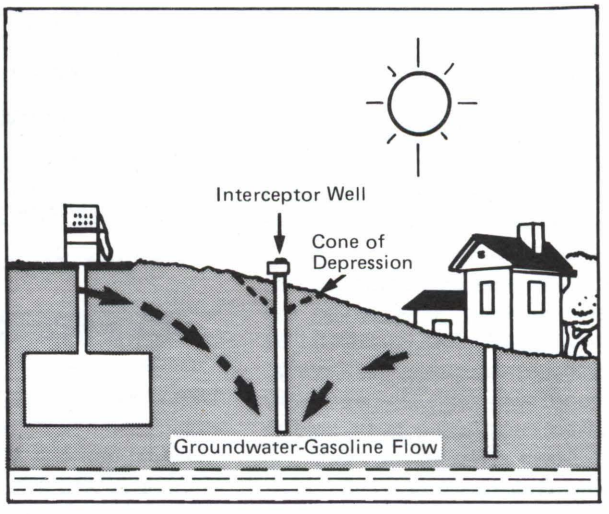

FIGURE B

How the contamination was reduced

When the truck broke the pipe connecting a pump to an underground tank, gasoline leaked out and began seeping downward until it reached a water-bearing zone of permeable rock called an aquifer *(Figure A)*. The gasoline then flowed with the water through the aquifer toward the wells serving the Beasley, Grimes, Alford and Taylor families.

Consultants hired to decontaminate the aquifer sank a well between the point where the leak occurred and the four families' wells, and pumped out both water and gasoline for nine months, creating a cone of depression and causing the contaminated water to flow away from the residential wells *(Figure B)*. Then the firm fed a mixture of nutrients and oxygen through the well into the aquifer. The bacteria in the local soil and water cooperated, and the mixture broke down the chemical compounds in the gasoline in the aquifer into harmless components. Such a technique is rarely used in Virginia but is one well suited to the limestone geology of the Poplar Camp area, according to Mike Dovel, a Virginia Water Control Board geologist.

"Establishing the source of underground leaks is usually difficult and sometimes impossible," Dovel added.

When Dovel presented the results of the test borings and dye study to the Citizen Board, it voted to turn the case over to the Attorney General's Office. Service Gas Co.'s insurer then hired a groundwater consulting firm to perform additional test borings at the service station. The consultants injected 7,500 gallons of dye-stained water into the soil at the leak site. The dye eventually appeared in the residential wells.

After these tests, Service agreed to a consent decree, which was drawn up to establish cleanup procedures. Under this agreement, the company was responsible for hiring consultants to engineer and carry out the cleanup.

For nine months, the consultants performed pumping tests on an interceptor well at the service station site and created a "cone of depression." This method — one of the most commonly used in groundwater cleanup attempts — consists of a strategically placed well that draws large amounts of local groundwater toward it. Contaminants are pumped out of the well along with water.

However, the pump tests done by the Service Gas Co. consultants were not designed to recover contaminants, but to determine aquifer characteristics and the possibility of conducting a successful bioreclamation cleanup. This method, which has rarely been attempted in Virginia, involves feeding a predetermined mixture of nutrients and oxygen into the groundwater through a well. If the bacteria in the local soil and water cooperate, the mixture will break down the chemical compounds in gasoline into harmless components.

"Bio-reclamation works best in underground conditions through which groundwater can move quickly — gravels and porous soils, or, as in the Poplar Camp case, cavernous limestone," Dovel explained.

By the end of 1985, benzene levels in complainants' wells had been lowered to less than 2 parts per billion (ppb). Toluene and xylene were less than 50 ppb on the average — the level the VWCB and Service Gas Co.'s consultants agreed to reach.

"However," Dovel said, "an unusually heavy rain could temporarily bring some contamination back to the residential wells." Benzene, toluene, and xylene levels in the interceptor well — used to create a cone of depression — have remained above the levels agreed on.

Groundwater Technology Inc., the consulting firm that Service Gas Co. hired to conduct the cleanup, believes that these levels are higher because that well drew groundwater — and the contaminants —toward it.

According to Dovel, Service has been notified by the VWCB that it is relieved of further cleanup responsibility because it has done as much as appears justifiable or effective. Dovel said the VWCB will periodically monitor the interceptor well to determine the rate at which the remaining contaminant is reduced by naturally occurring groundwater bacteria. "The groundwater in this case is probably as clean as we're going to be able to make it," Dovel added.

Service Gas Co. has spent about $125,000 in cleanup costs and has sold the Poplar Camp station to Shell. "We thought we were in the forefront of careful control of underground gasoline tanks," said Jack Crawford, a spokesman for Service. "A problem develops in two ways — people are unaware that it can develop, or they don't know how to get help when it does."

THE VWCB took action against Service Gas because the firm had degraded the state's waters. It was the responsibility of the citizens who had suffered as a result of Service's action to bring their own suit.

Beasley and three of his neighbors--Archie Grimes, Helen Alford, and Fred and Clestine Taylor--hired a lawyer in 1980 but their suit against Service did not go to court until 1983.

"Our wells were contaminated to the point that we could smell the gasoline," said Alford, who had to begin carrying drinking water from her niece's house in 1979 and is still doing so.

Beasley and Archie Grimes had begun supplementing their well water with spring water before the contamination occurred. Alford and the Taylors could not hook up to the spring after the incident because no more users could be accepted.

An appraisal was done of all the residences involved in the suit before the trial began. The jury was told that it could award the plaintiffs the appraised value of their properties plus interest to compensate for the time they had spent without well water. Only Beasley was awarded full property value. Alford received $9,000, and the Taylors received $10,000. No one was awarded interest.

Even though tests show that benzene, toluene, and xylene levels in the private wells are below the consent decree levels, Helen Alford and the Taylors can still smell gasoline in their well water at times. They do not feel safe drinking it or bathing in it.

The Taylors' house in Poplar Camp stands empty most of the time. Because they are afraid to use the well water themselves, they feel that they cannot guarantee a prospective renter or buyer that it is safe to drink; no one wants to rent or buy the house under that condition. Alford does not drink or cook with her well water, but she now uses it to flush the toilet and to do cold water laundry. She doesn't use hot water from the well because that often produces a strong odor of gasoline.

THE incident brought about one positive change for Service Gas Co. In 1979, while waiting for a decision concerning responsibility for the groundwater contamination, the company went into the business of conducting tests for leaks in underground storage tanks. Service bought Heath Retro-tite testing equipment and had several employees trained to conduct the tests. The firm currently serves about 20 clients a year in a 300-mile radius.

A problem has arisen with the testing business, however: Service Gas Co.'s insurer will no longer cover failures of the testing to discover leaks. Service Gas Co.'s underground storage tank clients must now sign an agreement to hold the company blameless if tests are incorrect and problems result.

Insurance coverage has become a problem in all facets of underground storage tank operations. Since January

"We thought we were in the forefront of careful control of underground gasoline tanks," says Jack Crawford, a spokesman for Service Gas Co. "A problem develops in two ways — people are unaware that it can develop, or they don't know how to get help when it does."

Cleaning up is costly business

Cleaning up contaminated groundwater is a complex, costly, and often impossible task. Jeff Sgambat, manager of the Annapolis, Maryland, office of Garaghty and Miller, one of the top groundwater consulting firms in the nation, said that costs can be divided into two categories. "When our firm handles a cleanup of groundwater immediately beneath a contamination site, the cost ranges from $10,000 to $100,000. Off-site contamination, which occurs because groundwater flows away from the site and carries contaminants with it, is far more expensive. It can run into millions of dollars."

Intended to examine the human aspects of water resources problems and research, *Focus on Water* is an occasional publication of the Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University. William R. Walker, director; Edward Born, assistant director for publications. Reader comments are invited.

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1986, the Insurance Commission has allowed exclusion of insurance of underground storage tanks; these exclusions in business policies must be approved by the commission.

Mike Floyd, head of Aetna's Engineering Safety Department, said that his company has been surveying its clients who own tanks. Aetna is using the results of its survey to notify clients about improvements or replacements they need to make in order to retain insurance for their tanks. "The ones with good tank maintenance programs will not be excluded," Floyd said.

Milton Flynn, an executive with the Cavanaugh Corp. of Richmond, an industrial petroleum supply firm that conducts tests for tank leaks, explained that it costs $1,000-1,200 to test three service station tanks. "Municipal governments and major oil companies have periodic testing, but smaller businesses usually can't afford this precaution," he said.

Kim Anderson, of the Virginia Petroleum Council, said that each of the council's member companies has developed a tank replacement program. Most companies and private stations are replacing old tanks with ones made of cathodically protected steel because these cost 30-40 percent less than those made of fiberglass.

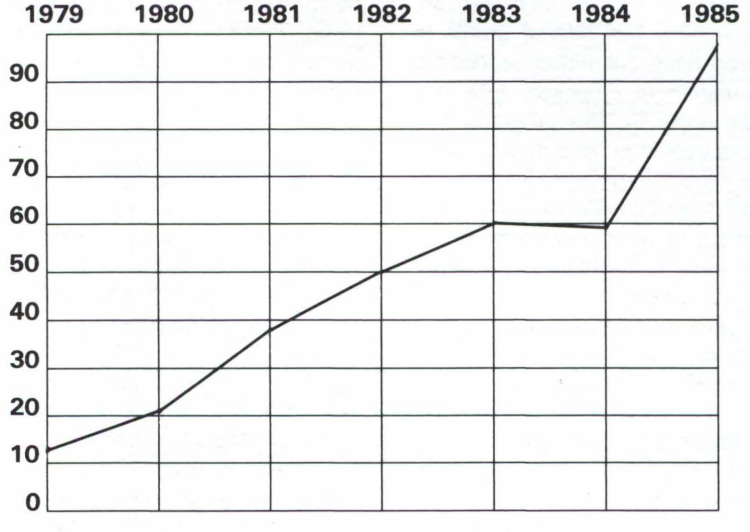
"Contamination of groundwater is not good publicity for oil companies," Anderson said. "Also, these companies want to be good corporate citizens." Another motivating factor is that, under a U.S. Environmental Protection Agency (EPA) ruling of May 7, 1985, all newly installed underground storage tanks containing petroleum products or other hazardous substances must be designed to prevent corrosion.

Oil-in-groundwater reports up 7-fold

Vernon Beasley's call to the Virginia Water Control Board (VWCB) was one of 13 complaints of groundwater pollution involving petroleum products received by the agency in 1979. As the chart *(below)* indicates, the number of complaints have increased seven-fold in the 1979-85 period.

"What is important to remember," says VWCB Geologist P.J. Smith, "is that the effect of these incidences is cumulative. In most cases, groundwater in the area of complaint will remain polluted for a lifetime."

The total number of groundwater contamination complaints has risen from 29 in 1979 to 129 in 1985 — a 4.5-fold increase.



Source: Hrezo, M.S. and M. Quesenberry, 1986. *Options for Managing Underground Storage of Petroleum Products in Virginia.* Virginia Water Resources Research Center Bulletin 150, Blacksburg.

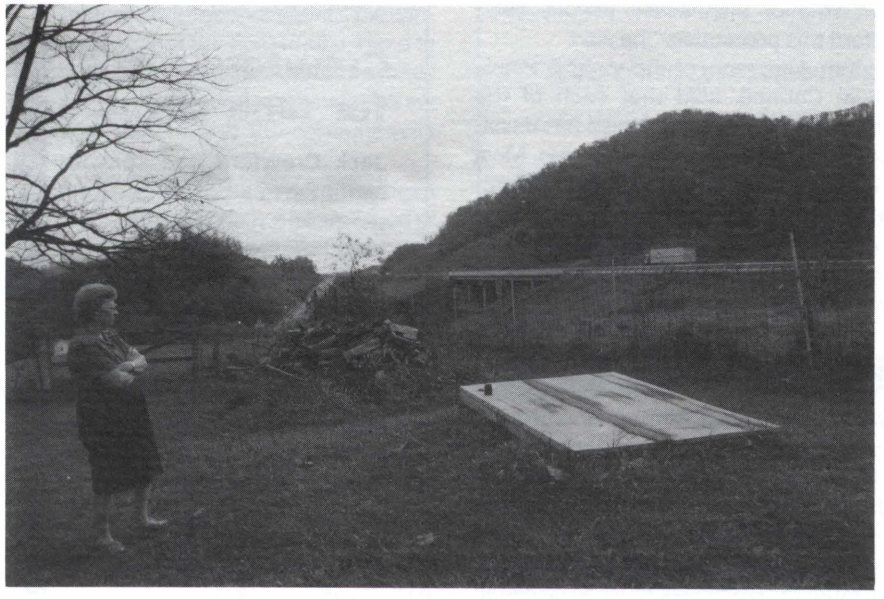
Crawford's tips for tank owners

Jack Crawford has spoken about Service Gas Co.'s experience at a meeting of the Virginia Petroleum Jobbers and a seminar attended by VWCB regulators. His advice to owners of underground storage tanks:

- You can be fined up to $10,000 a day if you own a leaking tank that is contaminating groundwater.
- Keep careful inventory so that any deviations in gasoline or oil levels are apparent immediately.
- Hire a professional to investigate if deviations occur.
- Keep a record of all details if you suspect a leak.
- If a tank is suspected of leaking, pump it out immediately.
- Make your insurance company take action. Don't let them dismiss the possibility that you may be responsible.
- Notify state and local authorities (the VWCB and local Health Department office) immediately — before they notify you.
- If you are responsible for groundwater contamination, have consultants draw up a workable cleanup plan and have it approved by the authorities. Begin the cleanup as soon as possible.
- Be vigilant during the cleanup process. "Keep in mind that the authorities can hit you with very large fines, too, if it can be proven that all possible steps were not taken promptly and efficiently."

A frightening potential exists for groundwater contamination from leaking underground storage tanks. The American Petroleum Institute estimates that the average age nationwide of tanks storing petroleum products is 17 years, and the average age at the time of tank failure (when a tank begins to leak) is 11.7 years. P.J. Smith, a professional geologist in the

ELIZABETH B. CRUMBLEY



HELEN ALFORD CONTEMPLATING HER WELL
"I wish people were more educated about these matters."

VWCB's Richmond office, estimates that corrosion is responsible for leaking in 90 percent of the documented cases involving underground storage tanks.

Petroleum products are especially vexing because only small amounts are needed to render groundwater unpotable. According to the EPA, each gallon of gasoline that leaks from an underground storage tank can contaminate 750,000 gallons of groundwater to a level of 1 part per million. At this level, water has a foul odor and taste and is considered unfit for human consumption. In addition, gasoline is composed of as many as 250 to 300 chemical compounds, many of which are either known carcinogens or acutely toxic. Lead in gasoline-contaminated water can cause central nervous system disorders if ingested, and bathing in such water can cause skin rashes and stomach disorders.

WITH partial funding from EPA, the VCWB has begun an underground storage tank notification and information collection program. Russ Ellison, a professional geologist who is in charge of the program, said the VWCB's first step is to send notification forms to Virginia businesses and individuals likely to use underground storage tanks.

"We expect 50,000 or more tank notifications in the state. This is a federally mandated program, which means that everyone who has a tank must register it or face enforcement action by EPA," Ellison said.

Tanks exempt from registration under the current law include septic tanks; heating oil tanks used for on-site consumption; farm and residential tanks containing less than 1,100 gallons of motor fuel; and hazardous waste storage tanks, which are regulated under a separate program.

Dennis Carney, storage tank and groundwater coordinator for EPA's Hazardous Waste Management Division, said the agency has offered grants to states that have submitted acceptable tank management proposals. EPA has two main goals for this program. The short-term goal is to have states implement the notification process and develop a data base from the information obtained. Eventually, EPA wants each state to use the data base to develop a state-level regulatory program.

"Our primary concern on the state level is to develop a program to protect groundwater from leaking underground storage tank contamination," Ellison said. "It's extremely expensive and often impossible to clean up groundwater pollution. That's why Virginia needs to gather detailed tank information and then develop appropriate state regulations to help prevent contamination.

"I want to stress the importance of our groundwater resource," Ellison added. "The only way to protect that resource from contamination from leaking underground storage tanks is to fully understand our current situation--and that understanding must come from an effective notification process."

The VWCB's Smith has some advice for owners of tanks: " 'Mom and Pop' businesses should tighten their inventory controls and should talk to their distributors about improvements. A good inventory control is the best way for tank owners to guard against extensive groundwater contamination from leaking tanks."

Tim Perry, a professional geologist in the VWCB's Underground Storage Tank Program, wants to warn people that current property owners can be held liable for previous owners' leaking tanks. "I'd like to see tanks removed after they're no longer in use. Hopewell, for example, has a city ordinance that requires the removal of all unused tanks."

Another warning he offers is that a major source of groundwater contamination is the home fuel oil tank. "A very small leak in a home tank might not show up in groundwater for years. Owners should be aware that if a tank is above the water table, water will probably not be found in the oil, so a leak can go unnoticed for years. A tank owner can be held financially responsible at any time, however."

As director of the VWCB's PREP office, Dave Chance frequently deals with groundwater contamination complaints. He sums up the need of Virginia's citizens to be aware of the dangers of leaking underground storage tanks contamination this way: "I know of no case in Virginia where the water has been made completely drinkable after pollution by petroleum products. Some of the chemicals in gasoline are water-soluble and their removal is usually too expensive for cleanup to be successful. Our main emphasis is to stop the source of pollution and to prevent the spread."

SAYS Clestine Taylor of the ordeal, "It puts a hardship on everybody." Helen Alford feels the accident that has so pervasively affected her life and the lives of others illustrates a need: "I wish people were more educated about these matters and the problems that can result."

Because some people weren't, a house stands vacant in Poplar Camp.

Water Center researchers propose management options

Margaret S. Hrezo, the Water Center's assistant director for research and administration, and Mattie Quesenberry, a former member of the staff, propose three approaches to the management of underground storage tanks in *Options for Managing Underground Storage of Petroleum Products in Virginia,* Bulletin 150 in the Center's research series, and discuss the pros and cons of each.

All three options would protect the state's groundwater, protect public health and safety, be suitable to Virginia's particular needs and conditions, and achieve maximum cost-effectiveness. However, they differ in degree of comprehensiveness, cost to implement, and uniformity.

The first option approximately parallels EPA's choice to use its groundwater strategy as a guide. After setting minimum statewide standards, it requires more stringent cleanup for Class I groundwaters (those aquifers highly vulnerable to contamination and either irreplaceable or ecologically vital), and provides some exceptions from those minimum standards for Class III groundwaters (those aquifers unlikely to be used for drinking water because of salinity or contamination). While relying on industry standards and focusing on early detection of leaks, this option does require the installation of observation wells with new and replacement tanks, which must be made of fiberglass or cathodically protected steel.

The advantages of this option are that it is "based on already known and understood industry standards, includes a flexible cleanup approach based on the use and existing quality of groundwater, and is the least expensive" of the options. However, it focuses on leak detection rather than leak prevention, which, some observers might argue, is more in keeping with the state's policy of nondegradation of water.

The second option also sets minimum statewide standards but calls for greater protection in the Valley and Ridge, Piedmont, and Coastal Plain physiographic provinces, where people are the most dependent on groundwater and groundwater's susceptibility to contamination is greatest. Thus, the focus would be on leak prevention. This option, write Hrezo and Quesenberry, decreases the risks to public health and of groundwater contamination but would cost more to implement than the first option.

Its advantages are that standards are based on groundwater use and vulnerability to contamination and that it imposes the additional costs of a more stringent management option only in those areas where the more stringent option is needed. Disadvantages "are increased complexity and cost in administration, greater costs to owners/operators in some areas than in others, and lack of uniformity that could be confusing to major oil companies. . . ."

The last option sets comprehensive statewide standards for both new and existing tanks, emphasizes leak prevention by requiring precision testing of all tanks, secondary containment and leak detection systems for new or replacement tanks, and phased replacement or retrofitting of existing tanks.

Advantages to the third option include "uniformity and commitment to leak detection as a means of implementing the state's nondegradation policy." The principal disadvantage is that, in relation to the other two options, it is the most expensive to implement and could pose a burden to gasoline retailers.

Before arriving at these options, the authors briefly describe the problem of leaking underground storage tanks in the state and examine the causes of leaks. Next they discuss issues surrounding the goals of such regulation. Then they examine existing federal, state, and local laws and how they would affect the formulation of a management system for the state.

Although the costs of implementing the options are not computed, Hrezo and Quesenberry have included a table with the costs of eight leak prevention and detection technologies on a per-tank or per-facility basis.

In the concluding paragraph of their report, the authors write: "The options are presented as a starting point for discussion. . . .They cannot and do not include all the social, economic, and political factors that will determine final choices. . . .The most appropriate program must rest with Virginia's citizens and its elected and regulatory decision makers."

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--Edward Born

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