DECEMBER 1986

OK Water NEWS

Toxicity Testing in the Stream: Something Old, Something New

In a day in which increased industrial pollution, along with problems of agricultural contaminants, are threatening water supplies across the country, methods of accurately measuring their effects on rivers and streams have become vitally important to human health. Environmentalists and health officials alike agree that aquatic life—whose home is often laced with toxic substances—serves as an accurate measuring stick for determining healthy rivers and streams.

Although water treatment systems are slowly improving, they are hard-pressed to keep pace with the widespread industrialization which has introduced a plethora of new toxicants into the environment. And laboratory methods of gauging water pollutants are sometimes inadequate when taking into account their combined effects under true stream conditions.

Black checks test organisms at Bluff Creek. Attached to one minnow bucket is a float which leads to an invertebrate cage suspended by a weight below the stream's surface.

Studies use "gilled guinea pigs" to diagnose waters' toxicity

To deal with this problem, OWRB Water Quality Division specialists are employing a method which uses fish and other live aquatic organisms as "gilled guinea pigs" to determine stream toxicity. The inexpensive and relatively simple technique, referred to as in-situ toxicity testing, monitors state water quality by determining the presence—or absence—of toxic substances or other lethal conditions through the mortality rate of select species. This particular method of toxicity testing is conducted in the actual stream environment. Experts say it will someday play a vital role in assessing stream life conditions.

Although in-situ toxicity testing has only recently been seriously addressed as a way of determining safe contaminant levels of Oklahoma waters, the method is not new. The technique was originally developed in 1925 by Dr. K. E. Carpenter who was concerned that lead mining was having a destructive effect on river fisheries. And researchers at Oklahoma State University—namely Dr. S. L. "Bud" Burks—have been working with in-situ testing for about 25 years.

"What better way to measure the toxicity of waters than to use a method

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which directly assesses how life is affected by point and non-point source pollution?" said Jerry Black, OWRB environmental specialist. Black and Burks have done a great deal of tandem research on toxicity and they are co-authors of several studies on that subject.

A recent amendment to the 1985 Water Quality Standards directed that certain toxicity tests be used to make standards more enforceable and to check on permit compliance when there is a justifiable reason to suspect impairment in the quality of receiving waters.

New pollutants emerge faster than we can develop criteria

"New pollutants are being introduced into the environment faster than criteria can be developed. As a result, for many toxicants, there are no standards to regulate them," Black said. "This problem is compounded when trying to unriddle the synergistic effects of these pollutants when they are combined in streams."

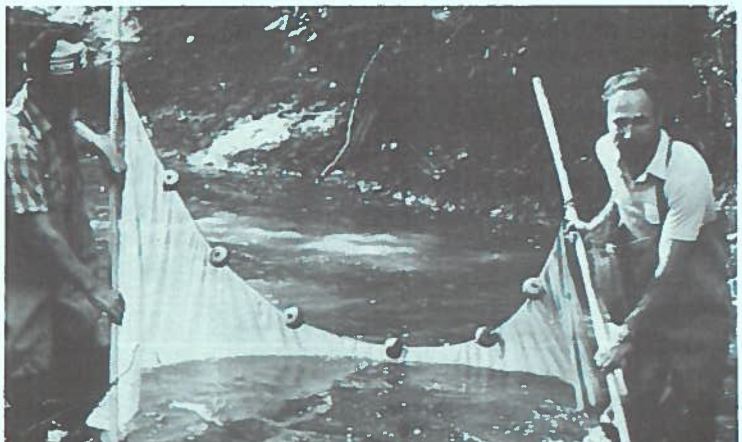
Choosing the correct species is critical in toxicity testing, he pointed out. Normally, the most sensitive species which is indigenous—or that which naturally occurs in the test stream—is used. Although fishes are normally used as test species, recently Black has introduced periphyton (small organisms, such as algae, which attach themselves to underwater surfaces) and aquatic invertebrates to the procedure.

Results of in-situ testing are expressed as an LT 50 (lethal time at which 50 percent of the organisms are dead) while lab testing results are typically reported as an LC 50 (lethal concentration at which 50 percent of the organisms are dead).

"In a nutshell, if a significant number of the test organisms die, then you know there is a problem," Black explained.

For fishes, trolling minnow buckets are ideal because they secure the species yet allow free activity. They also permit a relatively unobstructed flow which allows for exposure of the organisms to changes in the ambient water. In most cases, test organisms are left in the stream for 96 hours—unless the entire population expires before that time. The testing normally focuses on waste discharge points—often the most toxic areas in rivers and streams—unless non-point source pollution is of concern.

Test species are usually placed at two sites: one minnow bucket is tethered a few feet off the bank upstream of the discharge area (the control site), the other is set in a similar position below the mixing zone of the discharge (the test site). Sometimes a third site, about one mile downstream, is used to determine how far the effluent has a significant effect on the stream in question. Tests are usually conducted during the water's lowest flow, highest temperature and at the suspected time of maximum toxicity. The organisms are checked periodically to determine the all-important time of death—frequent observation is considered best.



Jerry Black and Dr. Bud Burks use a seine to collect fish at Bluff Creek in Oklahoma County. To prevent stress, organisms are immediately transferred to a large container filled with stream water.

Simple, but tedious to check test organisms every 4 hours

"Although the testing procedure is relatively simple, it is very time-consuming. At the very least, we check the condition of the test species every four hours," Black pointed out.

According to Black, despite the many advantages of in-situ toxicity testing, there are a few drawbacks.

"Naturally, it's impossible to actually control conditions at the site. Temperature and other factors may differ substantially between the impact site and the water in which test organisms are transported. Therefore, we discard any that appear stressed, diseased, abnormal or injured. Rainfall events can also throw off results unless we are trying to determine the effects of non-point source pollution, which is maximized during runoff events."

Not all testing is done outdoors. Lately, methods of testing toxicity in the laboratory have been improved. Site conditions can be simulated through the regulation of temperature, pH, light intensity and oxygen content—even stream flow can be closely duplicated.

"In many instances, we use both the in-situ and lab test because they complement each other so well," Black said.

"Eventually, we would like to further develop and simplify toxicity testing to the point where municipalities, industries—and even the public—can effectively conduct the operation to check on compliance with permits or standards.

"Someday, perhaps, even the Boy Scouts could help us locate pollution problems," he added with a grin.

mainstream

OKC Driller Wins Dispute

In a landmark ruling November 13, Oklahoma County District Court re-affirmed the right of a landowner to drill a well to supply water for domestic use, whether or not his well is in the corporate limits of a city.

The debate began in October 1985 when Nichols Hills resident L. G. Austin hired Oklahoma City well driller David Poindexter to drill a well to supply irrigation water to Austin's lawn, shrubs and flowers. In compliance with local regulations, Poindexter applied to the City of Nichols Hills for a permit to drill in the corporate limits, but his permit was denied. The city contended that private wells could be constructed only for the purpose of heating or cooling buildings.

Poindexter had proposed to drill Austin's well in the upper layer of the Garber-Wellington Aquifer which produces water high in sulfates, but suitable for watering. The city's wells draw higher quality drinking water from the lower level of the Garber-Wellington, so Poindexter argued that his client's well would not diminish the water supply of the city or affect its quality. Experts had testified that the two water-bearing zones of the Garber-Wellington are separated by many layers of impervious shale which would prevent any contamination of the city water supply.

District Judge Leamon Freeman ruled that the Nichols Hills ordinance was in conflict with an Oklahoma Statute that allows any landowner to drill a well on his property to supply water for domestic use. He said a local ordinance could not supercede State Statute. Judge Freeman affirmed that a city has the authority to regulate or permit water well drilling activity in its corporate limits, but cannot prohibit the drilling of domestic wells allowed by Oklahoma Statute.

The judge further required that such regulations have a basis in protecting the health, safety and welfare of its citizens, and the Nichols Hills ordinance did not have such a basis.

Theories Vary On Cedar Lake Mishap

On November 6, Cedar Lake in southwestern Canadian County, was full from heavy rainfalls. By November 10, in the place of the privately owned reservoir lay a waterless, muddy lakebed. Left high and dry, shareowners of the recreational lake wondered, "Where did the water go?"

Perhaps a more important question is, "How did all the water leave the lake, yet keep the dam intact?" Speculation has given birth to dozens of different theories.

Nevertheless, most agree that the key to solving the puzzle may lie 700 feet downstream of Cedar Lake dam where a large hole mysteriously appeared. Many believe that this cavern is where the lake's 1400 acre-feet of water washed out a county-line road and flooded a farm.

Harold Springer, OWRB Engineering Division chief, points out that much of the speculation involves the geology of that area. At the surface is a formation called the Rush Springs Sandstone—200 to 250 feet of red rock. Below the Rush Springs Sandstone lies the Marlow Formation, also primarily sandstone, laced with considerable dolomite and highly soluble gypsum.

Although the Marlow Formation is 120 feet thick, a one-foot layer of almost pure gypsum lies at the very top. Beneath the Marlow is fine-grained sandstone and, still deeper, lies the 200-foot thick Dog Creek Shale.

"We first believed that there was an internal deterioration of the dam where the structure meets the valley side. The water eroded a channel into the valley wall, through the gypsum layer until it reached the outcrop hundreds of feet away," Springer said.

Heavy rains—combined with the high lake level, saturated ground and increased groundwater movement—could have caused removal of the dam's support material. Perhaps the water eroded a channel through the gypsum which outcrops near the new hole, Springer added. Land subsidence stretching from the lake to the newly discovered cavern seems to support this idea.

A similar theory holds that the dam is sound, but the drainage was entirely due to the highly soluble gypsum that interfingers the Marlow Formation. It is possible that over time, the gypsum was completely dissolved, leaving a

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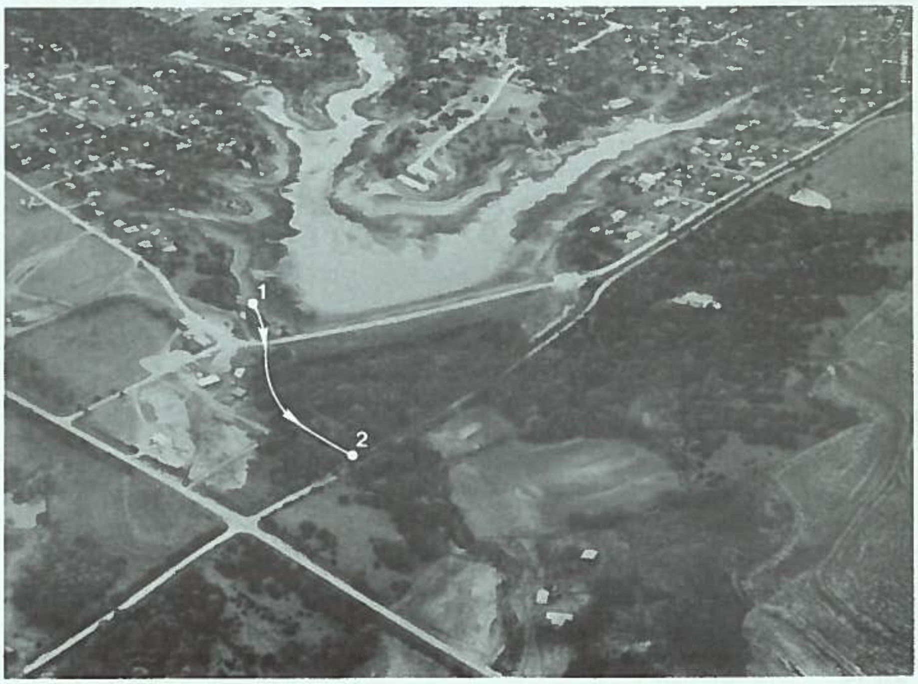
Shown below is the underground path of the water from the Cedar Lake dam abutment (1) to the county line road (2). After washing out a section of the road and spilling onto a farm, the water flowed into a nearby creekbed.



Mishap continued from page 3

network of channels and caverns. Then under increasing pressure, the land subsided and the water rushed out of Cedar Lake via this tunnel.

Yet a third theory involves the possibility of a sudden geologic disturbance—an earth tremor.

"Maps indicate that there may be several faults running through the lake and along the drainage path. Theoretically, a small tremor could have fractured the lakebed, allowing an exit for the water to empty Cedar Lake," Springer conjectured.

It must remain conjecture until a thorough investigation reveals the cause of the vanished lake, Springer said. An inspection trench is now being excavated at the site in an effort to solve the mystery.

ACTIVE CONSERVATION STORAGE IN SELECTED OKLAHOMA LAKES AND RESERVOIRS AS OF NOVEMBER 20, 1986

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
SOUTHEAST		
Atoka	98,175	79.1
Broken Bow	913,279	99.5
Pine Creek	77,700	100.0
Hugo	157,600	100.0
CENTRAL		
Thunderbird	105,925	100.0
Hefner	75,878	100.0
Overholser	15,858	99.7
Draper	85,110	85.5
SOUTH CENTRAL		
Arbuckle	61,713	98.6
Texoma	2,637,700	100.0
Waurika	203,100	100.0
SOUTHWEST		
Altus	132,886	100.0
Fort Cobb	78,346	99.9
Foss	182,760	75.0[2]
Tom Steed	88,971	100.0
EAST CENTRAL		
Eufaula	2,329,700	100.0
Tenkiller	627,500	100.0
Wister	27,100	100.0
Sardis	286,793	94.8

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
NORTHEAST		
Eucha	63,750	80.1
Grand	1,461,440	98.0
Oologah	544,240	100.0
Hulah	30,594	100.0
Fort Gibson	365,200	100.0
Heyburn	6,600	100.0
Birch	18,997	99.0
Hudson	200,300	100.0
Spavinaw	30,760	97.50
Copan	43,400	100.0
Skiatook	——	——[1]
NORTH CENTRAL		
Kaw	428,600	100.0
Keystone	616,000	100.0
NORTHWEST		
Canton	97,500	100.0
Optima	3,000	——[1]
Fort Supply	13,900	100.0
Great Salt Plains	31,400	100.0
STATE TOTALS	**12,138,775.00**	**96.1[3]**

1. In initial filling stage
2. Temporarily lowered for maintenance
3. Conservation storage for Lake Optima not included in state total

Data courtesy of U.S. Army Corps of Engineers, Bureau of Reclamation, Oklahoma City Water Resources Department, and City of Tulsa Water Superintendent's Office.

This monthly newsletter, printed by the Central Printing Division of the Office of Public Affairs, Oklahoma City, Oklahoma, is published by the Oklahoma Water Resources Board as authorized by James R. Barnett, executive director. Ten thousand copies are printed and distributed monthly at an approximate cost of 20 cents each.

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OKLAHOMA WATER NEWS
Monthly Newsletter of the
Oklahoma Water Resources Board
1000 N.E. Tenth, P.O. Box 53585
Oklahoma City, Okla. 73152

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