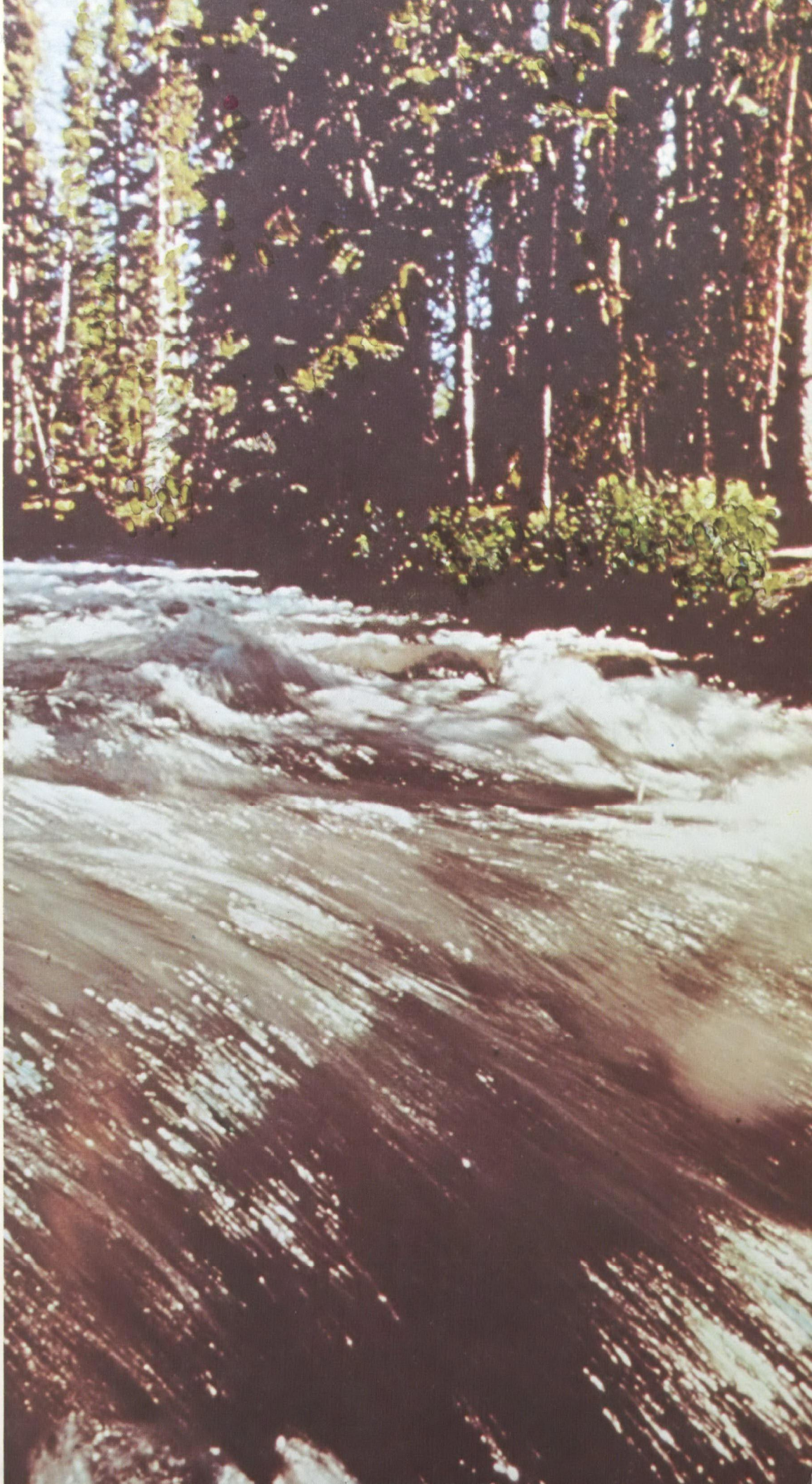
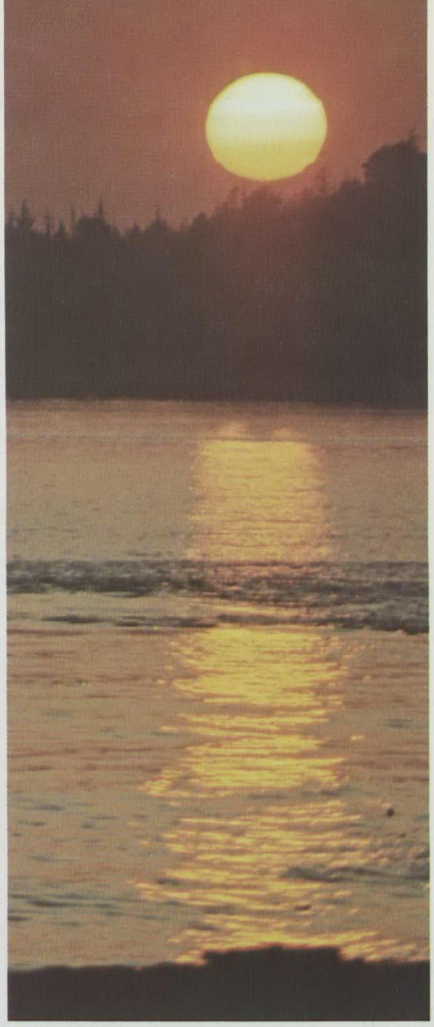
Quest for Quality



UNITED STATES · ENVIRONMENTAL PROTECTION AGENCY ·

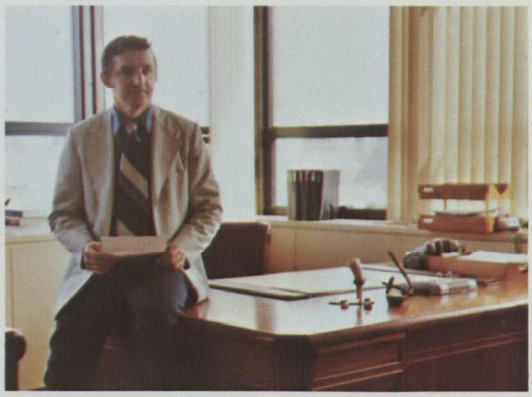


Your interest . . .

in the quality of our environment is keenly shared by the staff of the Pacific Northwest Environmental Research Laboratory at Corvallis, Oregon. Here, scientists are seeking solutions to problems affecting essential aspects of the world in which we live. Toward these goals, research programs are underway to understand and counteract the consequences of pollution in our coastal waters and inland waterways. For only with a greatly increased knowledge of our environment can we enhance and hand on to later generations the natural heritage which we ourselves enjoy.

Science is searching for the answer to eliminate environmental pollution . . .

The Pacific Northwest Environmental Research Laboratory (PNERL) at Corvallis, Oregon, was a part of the Department of Health, Education and Welfare in the middle 1960's and later the Department of the Interior. Its initial mission was scientific research on water pollution in fresh water lakes and streams, and in the coastal waters of the Atlantic and Pacific Oceans.



Director of the Pacific Northwest Environmental Research Laboratory, Dr. N. A. Jaworski.

PNERL's main research facility located in Corvallis, Oregon.

Today PNERL, under the direction of Dr. N. A. Jaworski, is one of nine associate laboratories of the National Environmental Research Center (NERC-Corvallis), which conducts a wide range of research on the ecological effects and the technological control of pollution. NERC-Corvallis is one of four national centers in the United States Environmental Protection Agency (EPA).

PNERL supplies reliable scientific data for setting and enforcing environmental standards of EPA. PNERL covers five programs:

- Coastal Pollution Research
- Eutrophication and Lake Restoration Research
- Eutrophication Survey
- Thermal Pollution Research
- Industrial Wastes Research

In addition, a Laboratory Services Branch provides analytical and support data for PNERL programs.

A common goal is the elimination of environmental pollution through understanding its fate and effects and learning to use waste products for man's benefit. Many pertinent questions must be answered: What has man done to produce imbalances in nature? Why does changing the balance in nature eliminate certain species and change the life patterns of others? How does nature react to pollution? Can nature's reaction to pollutants be reversed once the process has begun? What is the most expeditious and economical means of reclaiming or recycling waste products? PNERL scientists help find answers to these questions.

Samples undergoing laboratory analysis.

Man can no longer ignore his environment . . .

Nature follows a life plan with interdependent parts. The relations among these parts form an ecosystem that depends on natural balances. In the biochemical balance of nature, animals inhale oxygen and exhale carbon dioxide while plants absorb carbon dioxide and give off oxygen. This is part of the overall ecological balance, in which each organism relies on others and forms a pattern of relations within the environment.

The animals at each level of life form what is called biomass. The biomass at one level, in turn, determines the number of animals that survive in the next higher level of the ecological cycle. If the ecosystem is upset at any point, the entire biological system changes. Based on "survival of the fittest," or natural selection, the stronger or more adaptable organisms survive and the weaker or less adaptable ones die.

Man has learned how to adapt and change his surroundings for his own survival. Through better technology and greater production, man is creating more waste products. The growth of the human biomass has led to serious waste problems. For hundreds of years, humans have solved such problems by an easy method—their waste went into the nearest river, which carried it away to become somebody else's problem.

At first, the rivers didn't seem to be affected. Under the surface of the water, however, subtle changes were taking place. The ecosystem was beginning to be upset. Yet there was a lot of water and man thought he had an unlimited supply.

In the mid-twentieth century, man began to take a closer look around him. He tested the rivers and lakes and found that many of them were too polluted to support aquatic life cycles. Lakes were undergoing an aging process long before they were supposed to. The oceans were also being affected by pollution. Fish and shellfish were being poisoned by wastes.

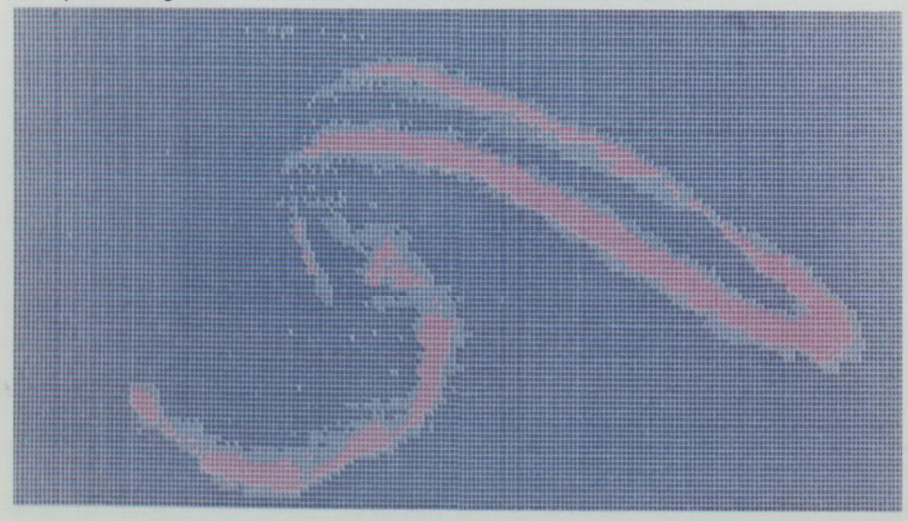
Man can no longer ignore the rest of nature. His past mistakes are catching up with him. It is time for man to evaluate and correct the lack of balance between himself and his environment. The life cycle of nature is also the ecosystem of man.

Clarifier basin separating solids and water as part of a waste treatment process.

Life-giving waters are among America's most precious natural endowments . . .

PNERL's facility for coastal waters research located in Newport, Oregon.

Computer diagram of acid waste distribution in coastal waters.



The Coastal Pollution Research Program directs and implements field, laboratory, and extramural research on the fate of pollutants in marine waters. Oceanographers, chemists, and engineers are examining how pollutants are dispersed and how they affect coastal waters and marine life. They study marine animals for their biological-ecological responses to pollutant materials.

Tumors on fish scales, abnormal bone changes in fish, and poisons eaten by fish or shellfish are common topics for biological research. The scientists also study the trace materials contained in the oceans, and the effects of barge dumping or waste discharge into coastal waters. Other pollutants, such as runoff from chemically fertilized land or storm drainage also affect marine life.

The program maintains laboratories and conducts research at two locations: Corvallis and Newport on the central Oregon coast at the Yaquina River estuary. The Coastal Pollution researchers recently completed studies on mercury concentration in Dungeness crab.

Another area being studied is off the New York coast. Scientists hope to determine the effects of sewage on bottom-feeding animals in the ocean. The macroinvertebrates (clams, sand dollars, sea worms) that live on the ocean bottom in that area are collected and sent to PNERL.

A laboratory model designed to simulate the pressure and temperature environment of this New York coastal area should point out what happens when

sewage sludge is deposited on the ocean floor. This New York study should also suggest methods for cleaning a polluted area; such information can then be used in other coastal studies.

Coastal Pollution oceanographers recently conducted a related underwater study at Lucaya, Grand Bahama Island, about 75 miles east of Palm Beach, Florida. These researchers lived and worked in an underwater laboratory on the sea floor fifty feet beneath the surface. The four-week study examined the chemistry of sludge deposited on the ocean floor. Each diver spent up to five hours a day working in the water. After six days, one storm, and a single fourteen-hour decompression period in the hydro-lab, the researchers surfaced. Concluding the study, surface-based divers made 100-minute no-decompression dives to the bottom to collect samples which were then returned to the Corvallis laboratory for analysis.

Many of the coastal pollution studies lead to mathematical models that can be used in other places for solving pollution problems. A math model uses various components——physical conditions such as water density, salt content, temperature, quantity of pollutants, and damage caused by pollution—to arrive at a computed formula for solving like problems in other waters. Scientists apply a math model to reduce the need for intensive special testing at each problem area. These studies will help describe how oceans are polluted.

Scientist/diver setting up equipment on the sea bottom to study the degradation of sludge.

A lake is born, grows old, and dies . . .

The Eutrophication and Lake Restoration Research Program studies the aging process of fresh water lakes. A newly formed lake contains few dissolved nutrient materials. There is little algae in its waters, the temperature is cold, and the oxygen levels are high. Cold water fish populate it.

As a lake ages, aquatic plants flourish, sediment accumulates on the bottom and the water becomes warmer. These factors help deplete the oxygen supply in the deeper waters. Slowly the cold water fish disappear and are replaced by fish which thrive in warmer waters.

The lake becomes eutrophic, which means well-nourished. As eutrophication increases, more sediment settles on the bottom. The lake fills with weeds, becomes a swamp, and finally evolves into solid land.

Left to itself, nature takes thousands of years to complete the aging process. Man, by his haphazard methods of waste disposal, has hurried the process. Sewage, dumped into clean, clear lakes, provides food for algae and aquatic weeds that grow so fast that they take over the lake. As the algae grow, they deplete oxygen in the water and choke out the ecosystem. Toxic blue-green forms of algae may poison the lake in this ecological change.

PNERL limnologists study the premature aging of lakes to develop programs and controls to restore the affected waters. Studies determine first where the extra nutrients are coming from and how life cycles within the waters are changed by eutrophication.

Ecological research determines how one group of organisms affects another group and how biomasses change to balance the ecosystem. For instance, there are methods for effectively controlling each type of algae. Those methods, however, could result in side effects that would harm other parts of the ecosystem.

A restoration project is now going on at Shagawa Lake, Ely, Minnesota. The town of Ely, during its peak tourist season, pumps over one million gallons of wastewater daily into Shagawa Lake. An advanced sewage treatment plant to remove over 99 percent of the phosphorus from Ely's municipal wastewater was completed in early 1973. The effluent from this plant is discharged into the lake.

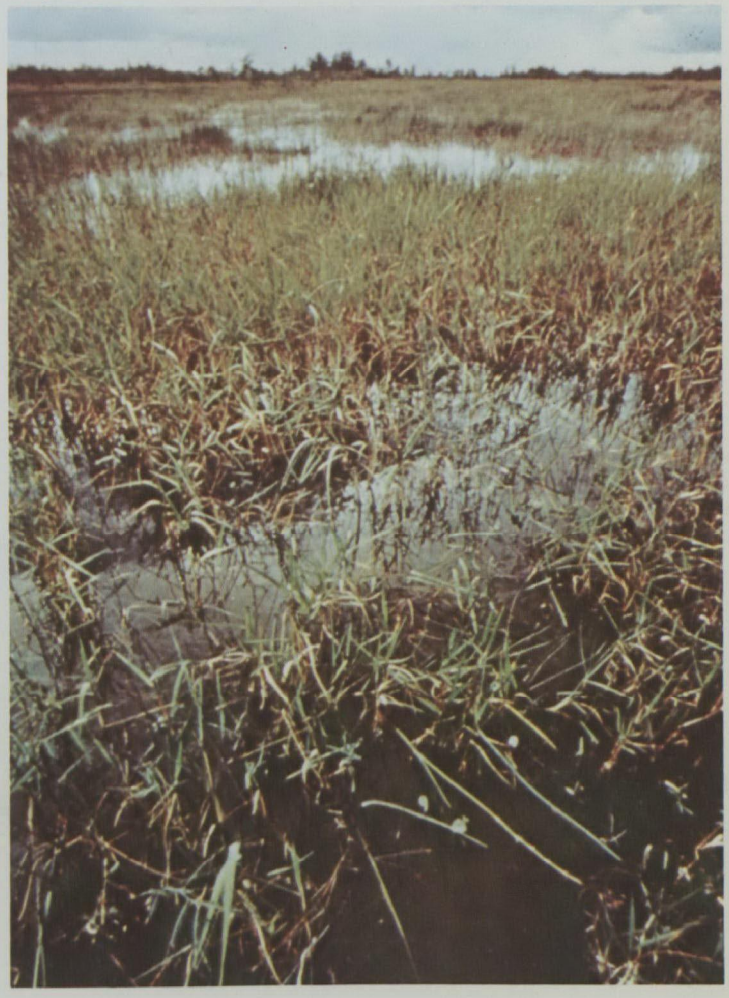
PNERL researchers are especially interested in the results of this way of operating since this is the first attempt to restore a lake while continuing to discharge a highly treated wastewater into it. The Shagawa Lake demonstration will help develop mathematical models that can be used to project what might happen where other lakes have similar problems.

To understand the eutrophication problem and how to combat it, limnologists must first know what the algae are and what they do to lakes. Controlled physiology tests that encourage algal growth are conducted at PNERL. These algal assays determine under what conditions algae flourish, what encourages algal growth, and the effects of nutrients and physical conditions on algae. The results from these tests should help lead the way to eutrophication control and reversal.

Glacial waters collect to form a lake as the first stage of the lake's life cycle.

Organic matter begins to build up and fill in the shoreline as part of the second stage.

Here the lake's life cycle is almost complete. A swamp now stands where water was before, and this will soon become dry land to complete a natural process that may take thousands of years.



Some lakes are in trouble today . . .

The Eutrophication Survey Program is conducting studies on accelerated lake eutrophication caused by man. Before the aging process in lakes can be slowed to normal, problem lakes must be singled out and the aging causes must be positively identified. The Eutrophication Survey Program and state agencies are cooperating in this venture.

Under Phase I of the survey program, PNERL established only two guidelines for a lake to be included — (1) that the lake be generally 100 acres or more in size and (2) that the lake receive municipal sewage. Using PNERL's guidelines, state pollution agencies identified lakes they felt needed study. Some of the identified lakes were already eutrophic while others were rapidly becoming that way. Some lakes which do not receive municipal wastes were included as control lakes.

Phase II of the survey program includes about 470 lakes in the 27 states east of the Mississippi River and some 300 other lakes in the states west of the Mississippi. Ultimately, the program will collect and analyze over 100,000 water samples from lakes, their associated streams, and municipal treatment plants. The National Guard in each of the 27 states east of the Mississippi volunteered to assist the survey by collecting monthly samples. After instruction on collection and preservation, each National Guard sampling team, over the period of a year, collects monthly samples from each stream that leads to a test lake.

The stream samples are sent to PNERL where they are analyzed for nutrients, mainly for nitrogen and phosphorus content. Test results are stored in a computer. After the end of a year's testing program on each lake, significant tributary streams, and municipal waste effluents, the results of the physical, chemical, and biological tests are compiled and evaluated by PNERL personnel.

Written reports give profiles of present conditions of lakes and show how much phosphorus or nitrogen enters a lake from sewage treatment plants and other sources. Predictions will be made on what might happen if nutrient inputs were increased or decreased.

When the study is complete for each lake, PNERL scientists will be able to answer the basic question of the survey: "What is the existing water quality of each lake and how significantly will that quality be improved with increased nutrient removal from the municipal sewage treatment plant effluents or reduction in nutrient inputs from other watershed sources?" With the answer to those questions, EPA will be able to assist state water pollution control agencies in outlining lake eutrophication problems for reducing over-enrichment, and for slowing or reversing the man-induced aging process of lakes.

Analyzer that counts individual organisms in water samples.

National guardsmen at work collecting specimens as part of the lake survey program.

Scientists installing a barrier in a pond to assist study of life cycles in lakes.

Heated water threatens aquatic life . . .

The Thermal Pollution Research Program studies the behavior and control of heat discharged to the aquatic environment. Aquatic organisms (fish, plant, micro-organisms) are affected in various ways by the temperature of the water.

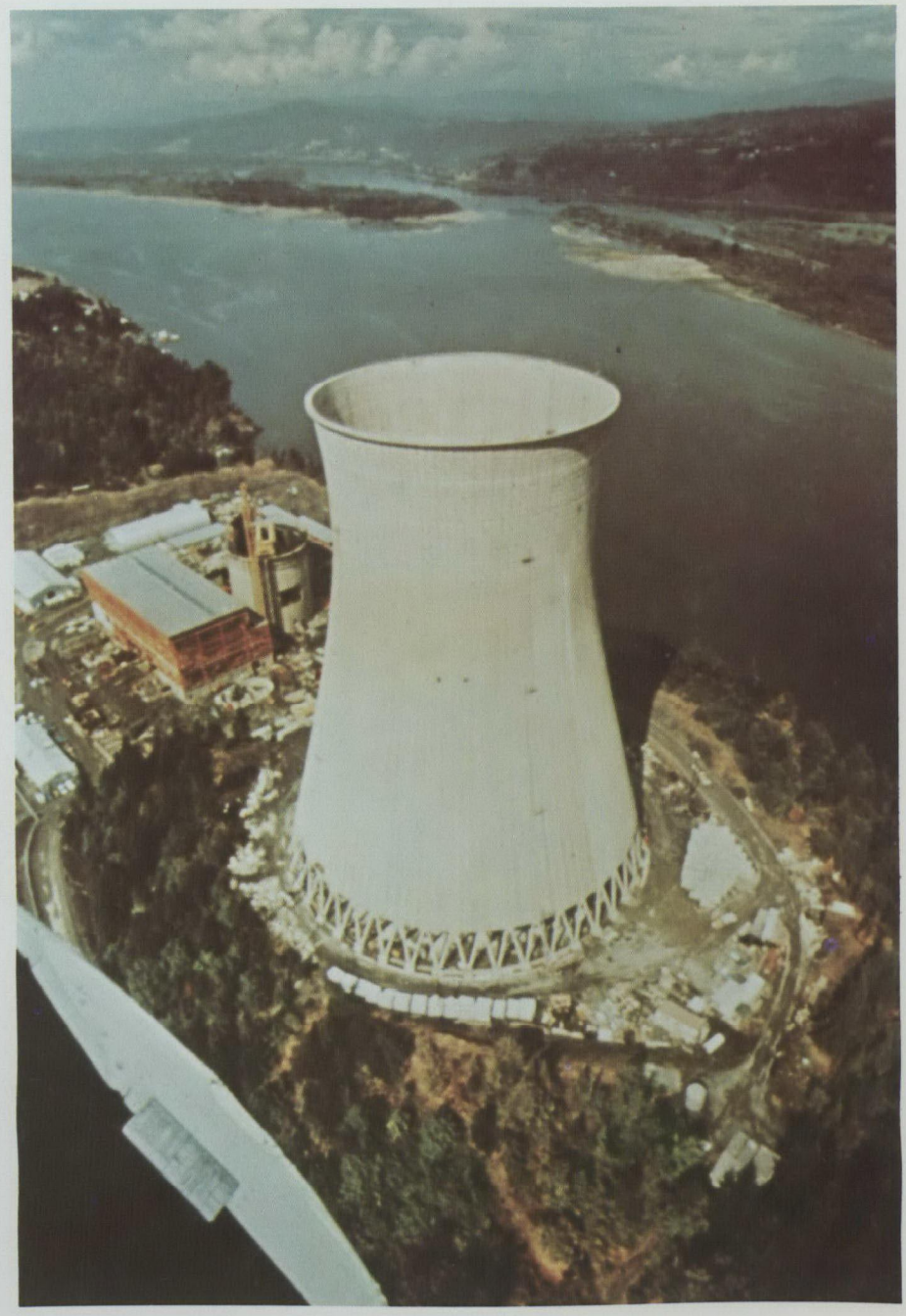
A change in water temperature which adversely affects the aquatic life in a river, lake, estuary, or ocean, is termed thermal pollution. Some species cannot tolerate extreme heat or extreme cold. Even slight variations in temperature can cause abnormal changes in behavior, migration, growth, and spawning of fish.

Generally, thermal pollution problems are caused by the discharge of heated water. Thermal electric power plants, both fossil and nuclear fueled, convert only a portion of their heat input into electric power. Most of the remaining waste heat is transferred to the cooling water in the condenser. For example, a one-million kilowatt nuclear power plant will cause a 28 degree Fahrenheit increase in the temperature of cooling water flowing through the condenser at a rate of 1000 cubic feet per second.

At many locations, heated water discharged into the aquatic environment could cause serious environmental problems. The scientists in PNERL's Thermal Pollution Research Program are working on methods for controlling such discharges.

Thermal pollution research activities are concentrated in three areas. Methods are being developed to predict the distribution of the heated water after

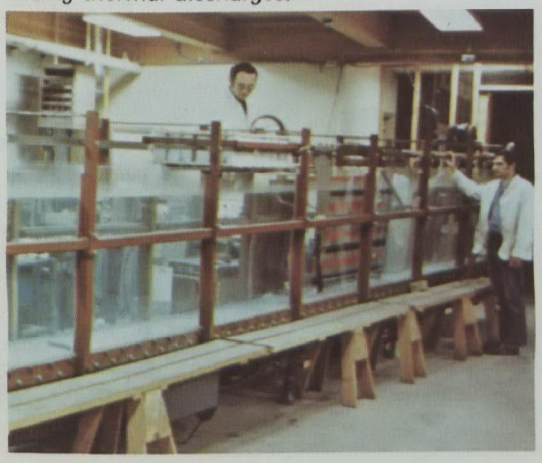
Cooling tower that reduces the temperature of water circulated through a nuclear power plant on the Columbia River.



discharge. Biologists need this information to assess the environmental effects of the temperature changes. Digital computers are used to solve complex equations that represent the heated discharge. Such mathematical models are powerful predictive tools.

Heated water being sprayed on blossoming apple trees to prevent freezing of buds and loss of later fruit production.

Researchers ready a towing channel for testing thermal discharges.



In addition, experiments are being conducted in a towing channel, 40 feet long and 4 feet deep. In these experiments, scientists use scale models of thermal discharges and study the physical processes that control how fast the heated water mixes with the cool, ambient water. The trajectory of the heated water plume is also studied.

Thermal pollution researchers also study methods to prevent excessively heated water from being discharged into the aquatic environment. Many evaporation devices, such as cooling towers, cooling ponds, and spray systems, are used to transfer waste heat directly into the atmosphere without heating adjacent water bodies. PNERL's work on these devices concerns their operation, cost and environmental effects.

Techniques for reusing the hot water from thermal power plants are also being studied. Research on heated water application for beneficial purposes is conducted. In one study, the Eugene (Oregon) Water and Electric Board was awarded an EPA grant to evaluate the use of heated water in irrigation and soil heating to improve the growth of agricultural products.

Thermal pollution research is conducted by both resident personnel and outside experts. Much of the work is funded by research grants and contracts to leading universities and research institutions. Technical assistance is also provided to nonresearch groups within EPA.

Industrial waste reuse and recycling can create valuable resources . . .

The Industrial Wastes Research Program has been conducting and funding research since 1967 to develop improved treatment systems for the food processing and pulp-paper industries. Engineers and scientists in this program advise industry on better ways to control, limit, and finally eliminate discharge of industrial wastes into surface waters. Finding ways to recycle waste into usable products is a major feature of this program.

Wastes from the paper and forest industries consist mainly of wood sugars, wood chips, sawdust, and bark. There are about 850 pulp-paper mills and 400 wood processing plants in the United States that formerly discharged waste products directly into the waters. Now nearly half these mills apply primary treatment for removal of settleable solids.

Under the Federal Water Pollution Control Act of 1972, all industry will be expected to have installed the best practicable treatment for waste by 1977. By 1983, industry must be providing the best available treatment, and by 1985, the national goal is to have no discharge of pollutants into the nation's waters.

Wood industries are constantly developing new products from former waste materials. Fiberboard is a good example of using waste wood chips, while bark mulch is another profitable use of a former waste. One mill is manufacturing alcohol from pulp mill wastes. Using various methods, several companies are studying a separation process called reverse osmosis to purify pulp and bleach waste. Other companies are experimenting with new processes to remove chemicals and reuse the clean water in milling processes.

Food processing industries are also studying their waste to find ways of using or reducing it. One problem is that it costs too much to treat food waste and dispose of it without reusing or converting it to a usable product. As a result, the food industries are looking for ways to modify their food processes and eliminate waste. They are also studying by-product usage.

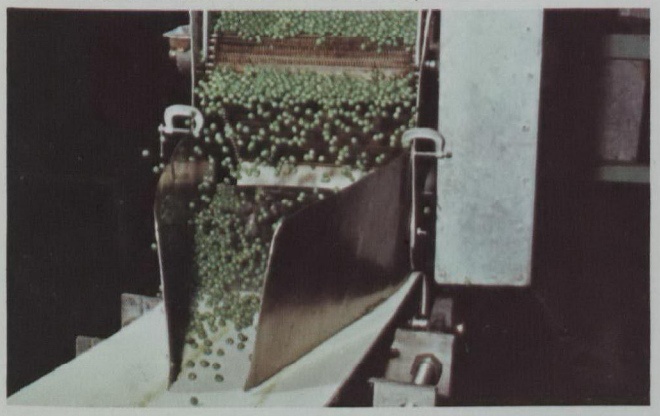
A canning industry is experimenting with a new way to peel peaches. The old method used about 850 gallons of water per ton of peaches peeled. By using rubber discs to peel peaches, only 90 gallons of water per ton are used. The new method also reduces the amount of organic waste carried away by the processing water.

Seafood processing plants are studying uses for their wastes. They are testing ways to recover and use protein from shellfish and fish processing wastes. The cheese industry has a problem disposing of whey, which is the acidic, watery part of milk left after cheese is made. Whey can be processed for use in human food as well as animal feeds.

The Industrial Wastes Research Program will continue to direct, supply money for, and review progress made by concerned industries until wastes, through reuse or conversion to useful products, are no longer an industrial problem.

Reverse osmosis unit that purifies water used in various types of manufacturing.

This processor blanches peas using a recently developed method that reduces the wastewater produced.



New sugar cane reaper that greatly speeds up production while substantially cutting pollution at the same time.

Experimental pyrolysis plant in operation that converts the solid material from liquid pulp waste into oil, gas, or activated carbon for use in filters.

Peaches being washed after the skins are removed using a new process that drastically reduces the pollution resulting from older methods.

Applied scientific methods provide the key to understanding water pollution problems . . .

The Laboratory Services Branch (LSB) provides factual, graphical, and mathematical data on samples and information required by PNERL scientists. LSB also provides chemical analyses and computer assistance for PNERL programs. Its scientists and technicians identify chemicals, and minerals in samples of water, soil, and plant life. By using a number of standard tests, they identify and quantify constituents in each sample analyzed.

The chemistry section of LSB performs nearly 240,000 tests on over 38,000 samples a year. Many different tests can be conducted on a sample. These include conventional ones such as conductivity, hardness, pH, turbidity, solids content, various forms of nitrogen and phosphorus, and most of the metallic constituents. found in water. Also, LSB can analyze water, sediments, and aquatic plants for components using modern equipment such as GC-MS, colorimetric equipment, flameless atomic absorption spectrophotometers, and others. The tasks performed are those that are required to support the research needs of PNERL.

On-site PNERL researchers casting a net to gather organisms for study.

Another PNERL researcher checks fish for evidence of contamination from industrial waste.

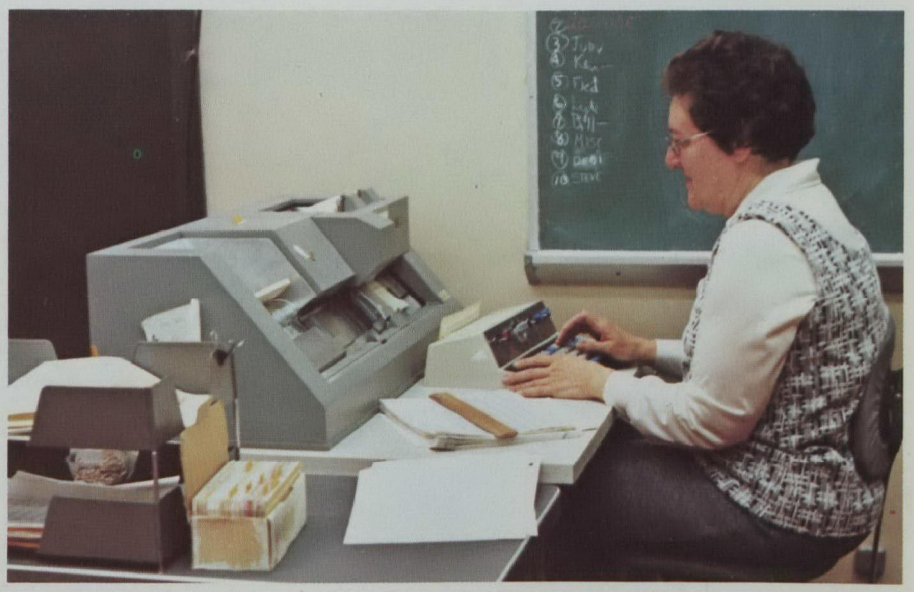
Facing Page:
Checking algal assay of lake water samples.

Test results from the various LSB labs are fed into computers. The results are used by project leaders and scientists. The computers are also used to develop mathematical models and develop cost estimates for various pollutant studies. Computer technicians at LSB constantly review the computer output and decide better ways to present scientific facts.

The electronic and glassblowing section repairs, modifies, and fabricates specialized equipment. The electronic components might be categorized as "black boxes," and the glassware as "see through" systems. The electronic components, assembled in a compact form, enable the scientists to perform many complex and difficult operations. The glassblowing function provides special glassware to assist the researcher in conducting experiments.

Quality control is the most important asset of data produced by LSB. To assure quality, all analytical results are routinely monitored. Quality control charts are provided to assure that LSB technical assistance is based on the best available criteria.

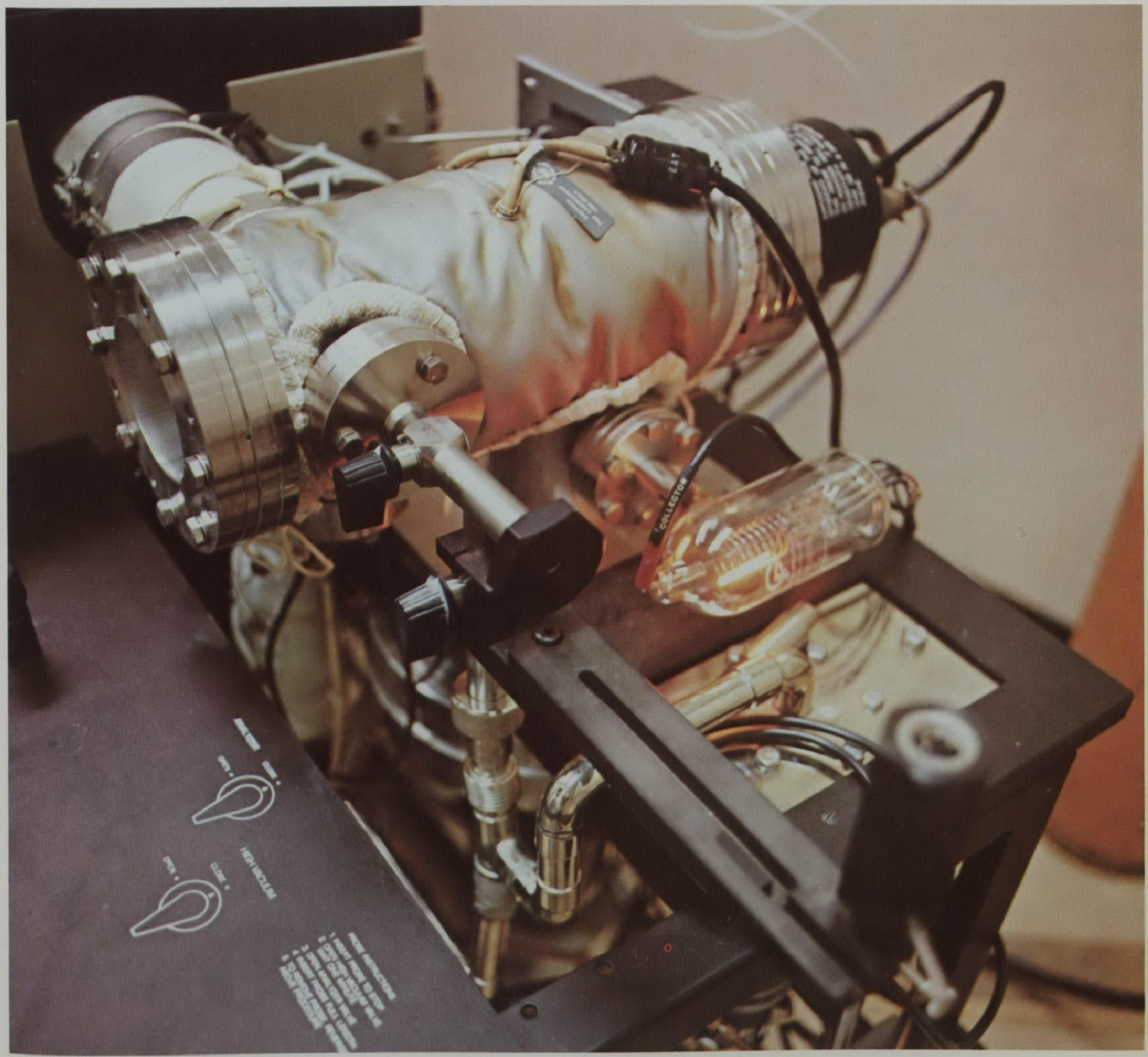
Sample being injected into a carbon analyzer for testing.



Research data being key punched on cards for storage and later analysis by computer.

Scientist adjusting equipment used to analyze for elements such as nitrogen and phosphorus in water samples.

Equipment used at PNERL to identify organic compounds by the gas chromograph/mass spectrometer technique.



Where do we go from here?

"We have a trust to fulfill for our children—an obligation that their environment must not be degraded by our generation, but rather enhanced. It is more than a promise. It is a duty.

"For it will avail us little if we construct the most powerful economy in the world at the expense of clean air and water. It is a poor trade-off if we destroy the beauty of this land and endanger the health of our citizens in a blind race for even greater profits. As Goldsmith put it:

' Ill fares the land, to hastening ills a prey,
Where wealth accumulates, and men decay ..
.. How wide the limits stand
Between a splendid and a happy land.'

"With your help, the Environmental Protection Agency will do its part to see that our cities, our towns, and our neighborhoods become attractive places for both work and recreation, where a creative and sensitive approach to use of our resources can yield dividends in health and well-being, and where we can take the lessons from past mistakes and use them in a rational way to improve the quality of life."

Russell E. Train, Administrator
U.S. Environmental Protection Agency
March 29, 1974

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