Safeguarding the World’s Largest Lake

In 1987, the Russian Republic enacted stringent air and water quality standards for Lake Baikal, in south-central Siberia, in an effort to save the lake and its ecosystem. Lake Baikal is the world’s largest (in volume), deepest, and oldest freshwater lake, and is also one of the most biologically diverse. However, it has been seriously damaged by the region’s urbanization and industrialization. Recently, a joint U.S.–Russian team of engineers, planners, and environmentalists evaluated the current state of the environment in the region and recommended that Baikal-area industries improve effluent quality, reduce air emissions, and develop reuse systems.

While still a republic, Russia also created the Baikal Law, which includes guidelines for water and air quality in the Baikal region catchment basin and air shed. The newly independent country is currently pursuing designation of the lake and its watershed as a United Nations World Heritage Site. This would mean that land management and cleanup plans would be established for the area to preserve the lake for future generations.

Water Quality Is Deteriorating

The lake’s water quality is, on the whole, quite good. There are isolated areas of pollution from urban and industrial sources in the northern and southern portions of the lake. Industry, water and wastewater facilities, paper mills, and agriculture are affecting the water quality, and air pollution from many of these same sources deposits toxic and acidic materials in the watershed. Yet, compared to other freshwater lakes, Baikal is relatively clean.

While the lake has more than 300 major inlets, there is only one outlet, the Angara River near the city of Irkutsk on the southwest side of the lake.

The lake’s primary inlet, the Selenga River, originates in Mongolia and flows past Ulan-Ude (an industrial city of more than 300,000) and the industrial town of Selenginsk before entering the lake’s east side through a huge delta. The Selenga accounts for about 60% of the lake’s freshwater influx and a substantial part of the pollutant inflow. The lake remains relatively clean because the total annual inflow is only about 0.26% of the lake’s total volume. The water turnover rate is, on the average, once every 400 years, which, when combined with very cold water temperatures, means that self-purification is a slow process.

Industrial wastes. While industries in Ulan-Ude are required to pretreat their wastes before discharge to the municipal...
Baikal: A True Natural Wonder

Lake Baikal, estimated to be about 25 million years old, contains more than $2.3 \times 10^5$ km$^3$ of water, which is equivalent to 20% of the world's freshwater supply. In surface area, Lake Baikal is the world's seventh largest lake (31,500 km$^2$). It is 636 km long and 48 km at its widest point with a maximum depth of 1637 m.

Known for its biological diversity, Lake Baikal has 1550 animal and 1085 plant species, two-thirds of which are found only in the area. The most notable are the Baikal seal, the only freshwater seal in the world, and freshwater sponges.

Scientists believe that the extreme clarity of the lake is strongly influenced by a microscopic crustacean (*Epishura baicalensis*), which filters large quantities of the lake water through its body.

The improper handling and storage of industrial sludges and residuals is also probably contributing to groundwater and surface water pollution.

Drinking water. A number of drinking water supply wells have been shut down because of contamination. The team was unable to determine whether the contamination was from faulty well construction or groundwa-
Lake Baikal Pollution Control Recommendations

- Upgrade all municipal wastewater treatment plants with additional tertiary treatment facilities to meet the discharge standards for Lake Baikal. This may include facilities for nitrogen and phosphorous removal, chemical coagulation, filtration, and heavy metals and toxic organics removal.
- Explore the applicability of wastewater reclamation and reuse techniques.
- Implement more stringent pretreatment levels to shift the burden of industrial wastewater treatment to the individual industries.
- Discontinue production of all bleached cellulose products at the Baikalsk Pulp and Paper Mill and convert the plant to a zero discharge operation. Both the Baikalsk and Selenginsk mills should continue to investigate the reuse of wastewater effluent and solids.
- Phase out the practice of sending solids and other residuals to unlined municipal solid waste landfills.
- Review and revise landfill design, construction, and use regulations. All regulations should be strictly enforced, especially for industrial solids and hazardous wastes.
- Equip all industrial facilities and mobile sources with adequate air pollution control devices, especially pulp and paper mills and thermal and electric power stations.
- Set up additional air pollution monitoring facilities throughout the Lake Baikal airshed to monitor stationary and mobile source emissions.
- Establish a regional laboratory with more sophisticated instrumentation than is available at small facility laboratories.
- Implement agricultural reforms including a ban of illegal or ecologically hazardous pesticides and herbicides. Establish regional regulations with strong enforcement policies for the storage, handling, and use of agricultural chemicals. Decentralize agricultural activities, prohibit animal feedlot operations, and establish best management practices for agricultural land management.
- Implement stormwater runoff control and treatment measures, and control for hazardous materials transport and storage.
- Increase capacity at wastewater treatment facilities to prevent plant overloading.
- Make adjustments to combustion temperature, air-to-fuel ratios, fuels used, and equipment modifications at power generating stations to reduce air emissions and possibly lower energy costs.

Pulp and paper mills. Two pulp and paper mills are significant sources of air and water pollution. Mill emissions have destroyed large areas of the surrounding forests. The team was unable to determine conclusively what, if any, air pollution control devices are available at the mills.

Solids disposal is a problem at the mills. Solids from the Baikalsk mill are dried in an experimental incineration process and then disposed of in a landfill. Solids at the Selenginsk mill are dried in clay-lined lignin ponds. The plant is also experimenting with composting dried solids for reuse. The clay-lined lignin ponds have vegetation growing on the bottom, indicating that the lining is probably unsound and contaminated water may be reaching the groundwater table. There are monitoring wells adjacent to the ponds, but the team was unable to determine whether pollutants had been detected.

The mills and their on-site power generation and wastewater treatment facilities have severe operations and maintenance problems. These problems could be solved with additional capacity, appropriate pretreatment facilities, upgraded maintenance programs, and pollution control devices.

Agriculture. Agriculture is an important part of the Baikal region’s economy. Sources of agricultural pollution in the region range from animal farms close to the lake to improper storage of agricultural chemicals—both are a serious threat to surface water and groundwater.

Team Suggests Solutions

The joint U.S.-Russian environmental team recommended several pollution control measures and innovative technologies (see Box). As the country adjusts to a free-market economy, it may be difficult to generate the revenue necessary to implement the improvements that must be made to ensure the protection of Lake Baikal. The team suggested user fees for wastewater treatment facilities or other public works operations, permitting fees or fines for exceeding discharge limits, and joint ventures with foreign investors. The team is also developing a land use plan and map for the Lake Baikal watershed.


Prognosis for R&D Funding Guardedly Optimistic

In 1993, expenditures for research and development (R&D) in the U.S. are expected to reach $162 billion, according to a forecast prepared by an international technology organization. This is an increase of $4.6 billion (2.9%) over National Science Foundation estimates for 1992.

Because part of the R&D increase will be absorbed by inflation—estimated to be just over 2% for 1993—this represents a real increase in R&D expenditures of less than 1%. This figure is considerably below the 10-year average increase of 3.1% in real R&D since 1982. The R&D growth rate has been slowing and is expected to continue to decline, perhaps even to the point of a decrease in real expenditures. A similar situation occurred two decades ago, with a very slow recovery.

Industrial financial support of research, accounting for 51.2% of the total, will continue to grow in areas related to electronics,