ENGINEERING

What Will the Rivers Do Now?

New Great Dams Are Clearing Their Muddy Waters and Clear Water Cuts More; What Will Be Effect on Beds?

By DR. FRANK THONE

See Front Cover

AMERICA'S great rivers are rapidly being won away from the ranks of the unemployed. Boulder Dam has gone to work; its "juice" now pours over the wires clear to the Pacific shore, and before long the million thirsty throats of Los Angeles will be wet with Colorado river water. Norris Dam is generating light for thousands of homes in Tennessee Valley cities and countrysides. Day and night the walls of the Bonneville and Grand Coulee dams rise higher—and even in advance of their completion are generating more than a little political heat. Thousands of years ago Egypt had its Age of Great Pyramids; now America dwarfs these ancient wonders of the world with an Age of Great Dams.

Most of us, when we behold these wonders that our hands have wrought, focus our attention on the dams themselves, and on the giant power plants at their feet. We give a thought, perhaps, to the tremendous artificial lakes they have backed up into what were empty canyons only a little while ago, and we bestow a passing look on the masses of churned water pouring back into the channels below.

Few of us, however, give that discharged water more than a second glance. Its work is finished, it has yielded its energy for conversion into electricity; it is now only a liquid exhaust, an aquatic ash, differing from other power-plant waste only in that it obligingly goes to the dump itself, instead of having to be hauled there.

Downstream Questions

Engineers, though, do not take quite so careless or inconsequential a view of that spent water. These fussy folk, trained to think quantitatively where the rest of us only guess qualitatively, still have questions to ask about that water even after they have squeezed all the electric juice out of it that they can get on a paying basis, and after they have taken toll of it for city use and irrigation.

So long as water moves, it is developing energy—doing work on something. It is the engineer's business to know about energy and work—how much, where applied, what doing. So he looks downstream from the dam, and asks his questions.

But he doesn't always get his answers on the spot. Frequently he has to take the river indoors with him, into his testing laboratory, and repeat the questions there.

Of course it isn't possible to take such mighty streams as the Colorado or the Columbia into even the biggest engineering laboratory. That would prove both expensive and messy. But for at least some of the answers a small copy of the river will do almost as well as the original, just as marine engineers can figure out the best lines for an ocean liner or a battleship by towing a model through a long tank, or predict the mile-high behavior of a Zeppelin or a new-type airplane by putting small replicas of them into a wind tunnel.

Wooden River

So when engineers began asking themselves, a short while ago, what the Colorado was going to do with itself and its channel after it has "gone through the works" at Boulder Dam, they did not try to answer it at Boulder. They came back to Washington, D. C., and in the laboratories of the National Bureau of Standards they built a wooden river. It didn't look at all like the Colorado at Boulder Canyon, to be sure, but it did incorporate the particular factors that were giving concern to the engineers.

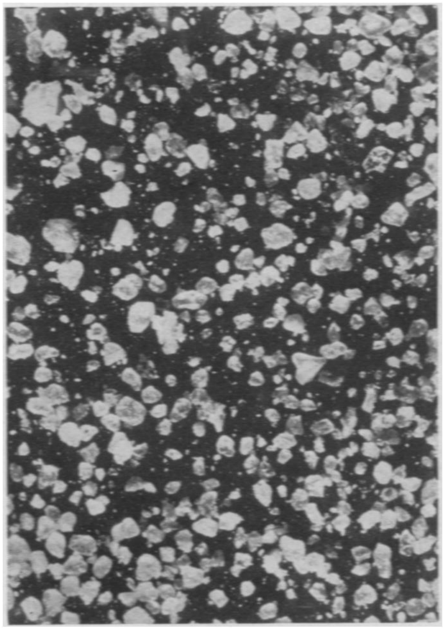
What they most wanted to know, in the particular downstream problem at Boulder Dam, was what the Colorado waters would do to the bottom of the river. Would the "scour" be faster or slower, now that the water gushes forth without the heavy load of silt it bore in the days before the dam was built?

For the water that comes out at the foot of the dam at Boulder—or of any dam, for that matter—is not the same as water in pre-dam days. A rapidly flowing river always carried along with it a considerable amount of mineral particles—sand and silt. The faster it flows the larger are the individual particles that it can carry, and also the larger is the total load.

When a dam is thrown across such a river, creating an artificial lake, the river behaves just as it does when it flows into the still water of a natural lake, or of the sea. It loses its velocity, and thus becomes unable to carry its load of mineral particles. The larger ones drop out first and the finer particles later. A delta is formed; the reservoir begins to silt up. The water becomes very much clearer than it was in the old original stream; only the invisibly fine particles, that are in what is technically known as the colloid state, remain in suspension as the water leaves the dam.

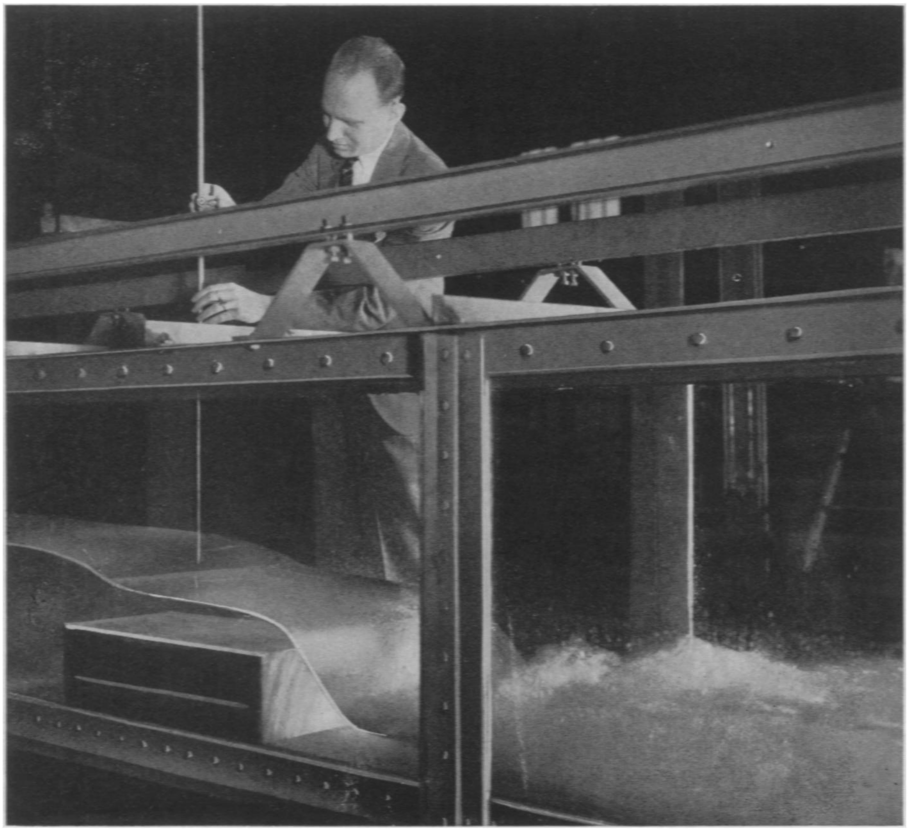
Inevitable Silt

Silting up is something that happens to all dams. When a dam-created reservoir has become completely silted up, the dam of course is useless. The lifetime of a dam is measured, among other things, by the number of years it will take for the silting-up process to complete itself. Engineers figure lifetimes for dams, as they do for roads, skyscrapers, bridges, battleships and all the other works of man. They set these figures off against



SAND

A sample from the bottom of the Colorado River for study at the National Bureau of Standards. It is magnified several times.



TAKING THE RIVER INDOORS
At the University of Minnesota, engineers study stream action through the glass banks of an artificial river.

the cost and usefulness of the dams, when they are deciding whether given projects are economically justified.

With this silt out of it, what will the re-cleared waters do when it rushes out of the enormous tailraces of the power plants?

The Bureau of Standards engineers built their wooden river to find that out.

Technically, the apparatus is called a flume. But modern "flume" differs by only a letter from the ancient Latin "flumen," which means a river, so that to call the contrivance a wooden river is not just a bit of fancy.

The Bureau of Standards flume is forty feet long, twenty inches wide. On eight feet of its bottom, bottom sand from the Colorado river was placed, and water was flowed over that at various speeds and with varying amounts of stuff already in it. The muddy water that originally coursed through the canyon was imitated in the laboratory by churning up fine particles of clay in the supply tank from which it was pumped to the flume, until three and one-half per cent of the weight of the water was made up of clay.

The work of the miniature river on its bed with clear water flowing was compared with its work when muddy water was used. Muddy water was found quite appreciably less efficient in causing scour on the sand bed. To cause the same amount of scour as clear water, it had to flow ten per cent faster than clear water under similar conditions. Sands somewhat coarser than those of the Colorado river bed were tried in the flume also, and it was found that with these the necessary increase in the velocity of muddy water was considerably greater, running as high as 25 per cent.

The difficult problem now facing the engineers is to correlate the results obtained with the little wooden river in the laboratory with conditions in the actual Colorado river, which is about 350 feet wide and 120 feet deep below the dam and travels about ten times as fast as the laboratory river, yet has the same sand bed. The exact answer to this question is not possible under the present state of hydraulic knowledge, but the results of this investigation indicate that a greater scouring away of the sand bed may be expected in the Colorado when clear water flows over it than was the case with the original muddy water. It is expected also that this scouring will progress gradually downstream.

While the results of this specific experiment will not apply directly to conditions below the other big dams now under construction or already in use, the general principle that clear water is a better "picker-upper" than muddy water will doubtless occupy the attention of engineers who stand at damsites and look downstream elsewhere. Where a river flows over a rocky bottom, the increased scouring effect of clear water will be a matter of less concern; but there are very few large rivers of this nature. Most of them, like the Colorado, have beds of sand; others are muddy-bottomed. These can expect downstream deepening if they are dammed.

Stone-Lined Rivers

The question of sidewise cutting, or bank erosion, was not taken up by the engineers in their attack on this particular problem. But it seems reasonable to conjecture that as clear water will scour the bottom faster it will also be more likely to cut more rapidly into the banks. This would not be a matter of particular concern at Boulder, where the power plants and other structures have their foundations set in solid rock, but it might be of considerable practical significance on the lower Mississippi and on similar streams where whole cities stand on loose-grained alluvial earth, highly susceptible to cutting.

So important is the matter of channel control in the older countries that in many places in western Europe small but troublesome streams have been given artificial stone linings where the cost appeared justified. A conspicuous example is Oberammergau in Germany, famous for its great Passion Play. The little river that flows along one side of the town had a bad habit of roaring into flood, when a storm had swept over the high mountain valleys that feed it. Sometimes it did this during a performance season, causing the throngs of visitors no end of trouble and losing the Oberammergauer people a great deal of needed revenue. So before the last performance season, in 1930, the people voted a heavy loan and cleared and paved their unruly stream. It was fortunate they did so, too, because 1930 turned out to be a rainy year in upper Bavaria. Yet for the first time the river stayed within bounds.

Hydraulic laboratories are coming to be regarded as necessary equipment in the great engineering schools. They are needed not only for studies on the effects of proposed dams such as the problem attacked by the Bureau of Standards, but for questions connected with levees, channel straightenings, diversions for industrial purposes, introduction of large sewers and other sudden additions of water, presence and removal of rocks, sandbars and artificial obstacles, and a score of other things that engineers need to know.

A novelty is the "glass river" used at the University of Minnesota. This is a flume with sides of glass instead of wood or metal. This permits the research engineer to study the up-and-down weaving of the currents, as well as their sidewise and eddying motion—a kind of observation not possible either with the older type of flume or with the rivers themselves.

Abroad, hydraulic laboratories are a story at once old and new. In such countries as France and Germany, engineers had them to work with before they were known in America. On the other hand, they came to Russia only since the Revolution. But Russia is a land of mighty rivers, resembling the United States in that respect at least, and the Soviet engineers are trying to make up for lost time by building the "biggest ever," when they have a hydraulic problem to tackle.

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MEDICINE

Little Grains of Starch Stop Growth of Cancer

A HINT that starch grains injected into cancerous tumors will stop their growth and in many cases cause them to disappear is contained in one of the 33 cancer researches in America and abroad supported by the International Cancer Research Foundation grants totaling over $300,000.

This hopeful experiment was made on a mouse tumor by Prof. Robert Chambers and C. G. Grand, of New York University's Department of Biology.

Injections of starch grains "produced a marked infiltration of polymorphonuclear leucocytes into the tumor." Leucocytes or white blood cells are the soldiers of the blood stream that fight invading germs. The accumulation of leucocytes inhibited further growth of the tumor and, in many cases, the tumor disappeared completely. Inert particles, like charcoal, did not produce the effect. So far the method has been applied to mice only.

The ultimate solution of the cancer, "the greatest unsolved problem in medicine today," will come from research by well-trained investigators, said W. H. Donner, president and founder.

"Why is there so little money for cancer research?" asked Mr. Donner. "The answer lies probably in the fact that research appeals only to the intellect. Hospitalization and treatment for the amelioration of suffering make an obvious emotional appeal to a large public; the alleviation of pain is humanitarian, and a necessary function of civilized society.

"The solution of the cancer problem, however, is an intellectual rather than an emotional matter, because it will come from research. Essential though care and treatment are, they can not be of the slightest help in preventing the development of malignant disease in the next sufferer. For him or for her, hope lies in the laboratories."

Human cancer cells and tissues have been kept growing for years in glass dishes and fed artificially, the report of the Johns Hopkins Cancer Research and Tissue Culture Laboratories reveals. The "J. D." human tumor strain has been maintained in pure and continuous tissue culture for 5½ years and an "A R." strain has existed 4 years. A number of human brain tumors had been cultured for almost a year when the report was submitted.

A new theory of cancer formation is suggested by experiments of Dr. A. Haddow of the University of Edinburgh. Chemicals from coal tars produce certain kinds of cancers and the new idea is that these carcinogenic hydrocarbons actually inhibit growth of the cells instead of stimulating them. The cancer is believed to result from the rise of a new cell race that rebels from the prolonged retardation of the growth of normal cells and multiplies rapidly forming the cancer.

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PSYCHOLOGY

Study Debunks Idea That Geniuses Are Born Queer

IF MEN of genius are eccentric or insane, it is not because all geniuses are born queer, but possibly because of lack of understanding in their education and family life, Dr. Harvey Zorbaugh, director of the Clinic for the Social Adjustment of the Gifted, New York University, told an audience at the Woods Schools, Langhorne, Pa.

Among a hundred gifted children whose development is being watched at the Clinic, five are so extremely gifted as to be clearly in the class of potential genius. In terms of IQ, these children all score at or above 180; a "normal" score is 100. One child registered 204 on this mental scale; the others were respectively 180, 190, 196 and 200. Such genius is rare, Dr. Zorbaugh said. Probably not more than 24 would be found in all New York's 1,086,416 public school children.

All are well adjusted, socially competent young persons, Dr. Zorbaugh told the Conference on Education and the Exceptional Child meeting at Langhorne.

"In three generations of the five families of these children there is but one relative who may be suspected of a psychotic episode," he said. The mother of one child is eccentric although it has never been necessary to put her in a hospital. All the other relatives seem