Operations were controlled to a very large extent by the fact that all materials had to go in over the railway siding, and on that account it was economical to work from the west side of the river, notwithstanding the fact that the bulk of the concrete was required on the other side. If railway connections could have been established on the east side of the river, much of the re-handling of concrete and long hauling would have been done away with.

Work was started on the west side of the dam after the railway siding had been laid up to that point. The earth embankment, with its concrete core wall, and the west abutment were the first items completed. The siding was then advanced along the fill so that cars of material could be brought close to the work. A stiff-leg derrick was set up on one side of the siding, and the mixer—with its storage and measuring hoppers—on the other side, where it could be easily reached by the derrick. All materials went in by

FIG. 7—DAM UNDER CONSTRUCTION—PART OF MIXING PLANT AT EXTREME LEFT—TRESTLE TO POWER HOUSE IN LEFT FOREGROUND

railway, and the sand and stone were unloaded by the derrick and a clamshell bucket. This derrick handled nothing but concrete materials.

A narrow-gauge track, for the operation of the flat car that carried the concrete, was laid from the mixer to the west abutment. At the same time the cleaning of the river bed and cofferdamming were commenced at the west end of the dam. Flash-boards had been erected along the west end of the old dam so that the water was diverted from that side when the cofferdamming was started. Novel and economical cofferdamming methods were developed for the work, the cofferdams being made of concrete and incorporated in the dam itself, thus effecting a great saving in cost and time.

The cofferdams when pumped out proved to be very free from water and the remainder of the footing was placed in the dry. In one case a rather heavy "geyser" was encountered, but it was led off in a 12-in. pipe, so it did not interfere with the concrete.

This method of cofferdamming has many advantages, any one of which fully justifies its use. Not only does it save time and material, but it also makes a better job. As each cofferdam was completed and the footing poured, work was proceeded with on the upper sections of the dam. Three sections were left open at different points in order to take care of the water that came down the river. These were afterwards closed by forcing a heavy 12 by 12-ft. frame-work down the piers, over the opening, and sheeting it in place. This dried the section and allowed the remainder of the work to be finished in the dry.

Much of the concrete work was done in severe winter weather, and precautions had to be taken to prevent damage by frost. Warm water was used in the mixer, and the sand and stone were heated in the usual way by steam lines passing through the storage piles. Over and around the portion of the dam that was being concreted, there was built a light frame-work from which tarpaulins were hung. Live steam was kept in and around this rouse for a sufficient time to prevent any damage. These precautions retarded the work somewhat, but they proved effective; practically none of the concrete was damaged. A 90-h.p. locomotive boiler was reserved simply for the supply of steam for this purpose.

As the dam progressed across the river, the narrow-gauge track from the mixer was extended with it. In the pouring of the deck, the concrete was handled in a steel side-dump car which dropped the material right where it was required.

The power house site was unwatered by practically the same method that was used for the dam. In this case, however, only one wall was necessary, as the mill building and the river bank formed the other sides. The site was pumped out and the excavation of gravel and large boulders was made with the aid of two guy derricks. When bed-rock was uncovered, the rock drills were put to work and sufficient rock was removed to allow for the draft tube. The draft tube was set and the concrete of the surge tank floor poured around it.

These buildings were on the opposite side of the river from the concrete plant and about 300 ft. downstream from it. In order to get the concrete to them, a light low timber trestle was built diagonally across the river. The concrete was dumped from the car on the deck of the dam to a bottom-dump bucket on a flat car on the low trestle. The trestle sloped downstream, so the loaded car travelled by gravity; a single-drum hoisting engine pulled the car upgrade.

At its destination the bucket of concrete was picked off the car by a derrick and carried to whatever part of the work it was required. Two buckets were used so that while one was being emptied, the other was going for another load. For many parts of the work the buckets had to be passed from one derrick to the other. Over 3,000 cu. yds. of concrete had to be poured in this section, so it was necessary therefore that the handling methods should be rapid and efficient in spite of the awkward location of the buildings.

The surge tank walls were 4 ft. thick and had to be waterproof; considerable care was taken, therefore, with the form-work and the pouring. For the forms 2-in. dressed lumber was used, and 4 by 6-in. lumber for the studs. Forms were built with the boards vertical instead of horizontal, so that better spading could be done. The results fully justified the method.

A protecting wall was built against the river bank so that the tailrace waters would not scour it away. When this was finished, the whole tailrace was dredged with clam-