ADDING SPILLWAY CAPACITY

TO

EXISTING DAMS

by

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SUMMARY

This short paper discusses the work required to build a new side channel, stoplog-controlled spillway at Gull Pond, Newfoundland; the advantages of "trigger" stoplog release mechanisms; the addition of spill capacity by means of an overflow side channel concrete spillway at Bearspaw in Alberta; the complete rebuilding and enlargement of the crest spillway at the Ghost Dam, Alberta.

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INTRODUCTION

The science of hydrology has advanced rapidly in the last few decades, resulting in more accurate calculations of the flood potential at existing dams. Moreover, concerns about dam safety, particularly from overtopping during an exceptional flood, have resulted in the requirements to build new spillways and add spillway capacity at existing hydropower developments. Three case studies are described in this brief paper, and the reader is referred to the references for more data.

GULL POND

The Gull Pond storage dam was built in 1931 to include a central 10 meter high concrete dam with a stoplog controlled spillway and a one meter square low level outlet gate. The dam was flanked with homogeneous earth fills tied into the rock abutments. Over the next 50 years, the concrete deteriorated to such an extent, that reconstruction was deemed necessary.

Studies indicated that the most economic repair method was to build a concrete spillway with a stoplog control into the left abutment, and excavate in the rock to form a side channel spillway to return the flood waters to the river. The excavated rock from the channel was used to cover the concrete dam as shown in Figure 1 below, and a plan of the arrangement is shown on Figure 2.

The concrete spillway has 15 stoplog openings, each with 2m. long logs, for a crest length of 30m. The old spillway had 12 openings with 6ft. logs for a total crest length of 22m. resulting in a capacity increase of 36% for the new spillway. A hydraulic model of the spillway was built and tested by students at the Memorial University. Construction was completed in 1982.

To facilitate construction, the headpond was drawn down so that the new concrete weir could be built in the dry. For the upstream shell of the dam, the bottom layer of rock (4, below) was dumped in the wet until rock was above water, thus permitting the remainder of the dam to be built in the dry.

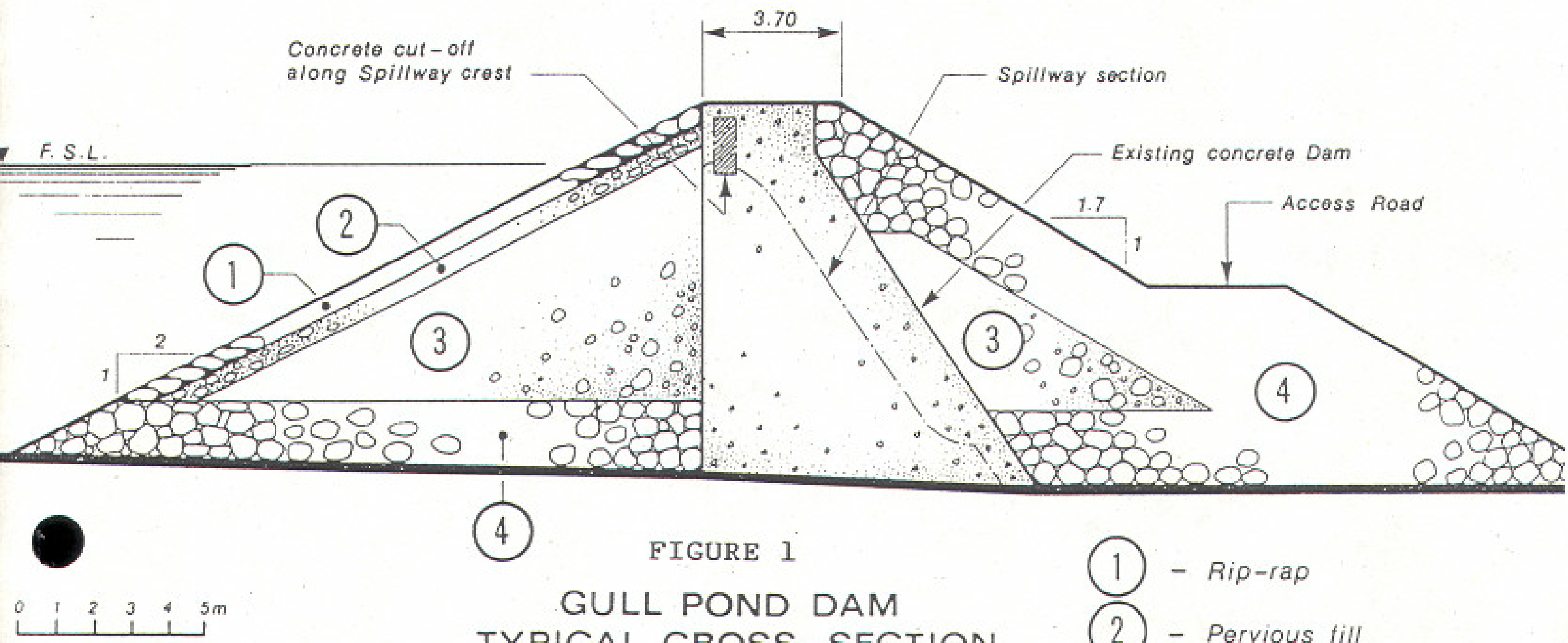

FIGURE 1

GULL POND DAM
TYPICAL CROSS-SECTION

1 - Rip-rap
2 - Pervious fill
3 - Common fill
4 - Rock fill

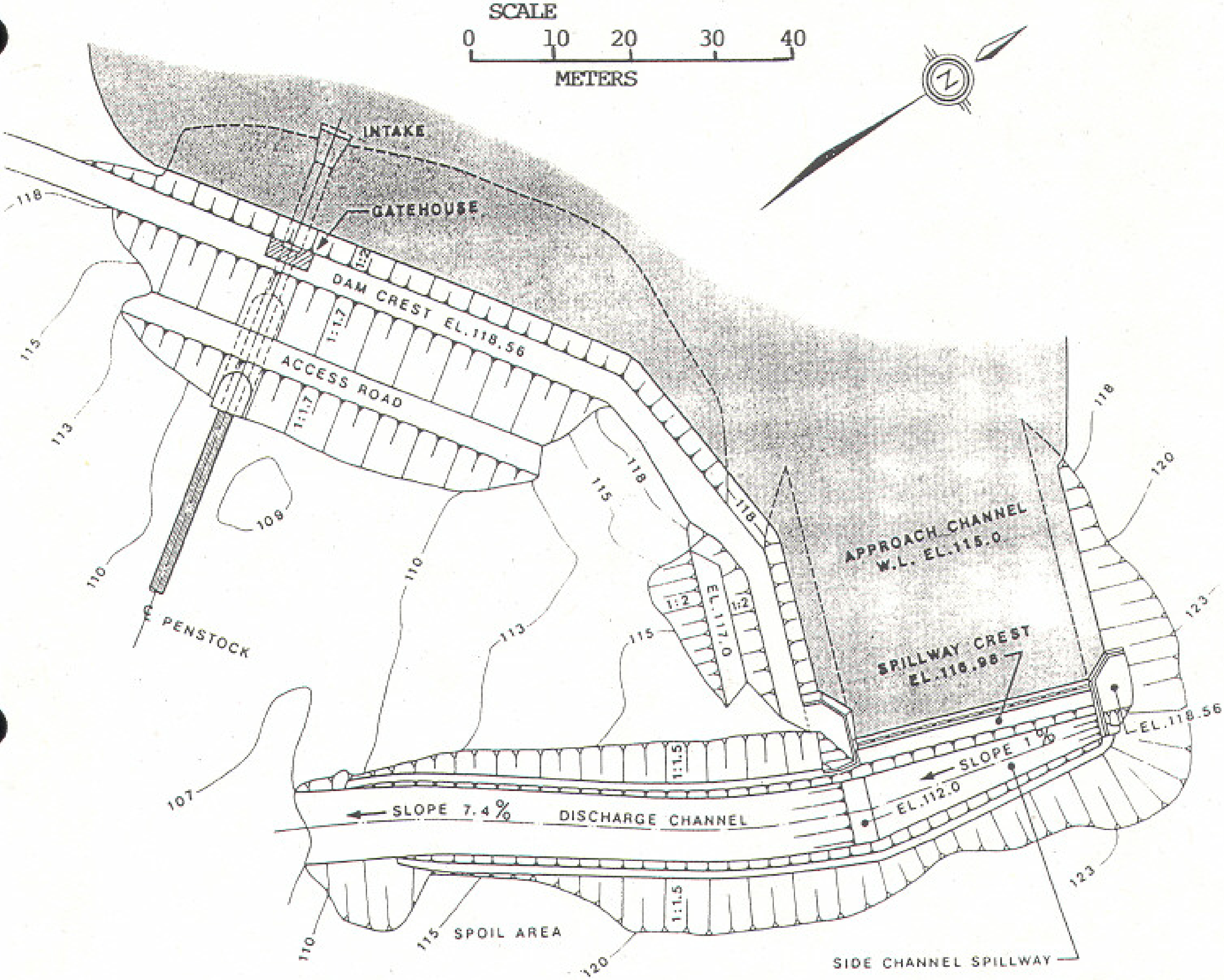

FIGURE 2

GULL POND DAM GENERAL ARRANGEMENT

STOPLOG RELEASE TRIGGERS

Stoplog controlled spillways are somewhat of an anachronism, a hold-over from the days when powerplants were staffed and operated manually. However, they are still around and need to be operated by at least a two man crew. Where the reservoir is small and can rise rapidly, quick action is often required by operators.

What is needed at these spillways is a simple device to quickly release the logs in an emergency, should the operators arrive late at the spillway, or if only one man can reach the spillway in time. Such a simple device can be obtained by the use of a wide flange steel section to split the opening in two, as shown on the following Figure 3. The bottom of the steel section is held in place with an L-shaped anchor bolted or set into the concrete, and the top is secured in place with a stainless steel pin which can be pulled free with a common portable jack.

This device has been used at the St. Marguerite Dam in Québec to control six openings, at the Lachute Dam, also in Québec to control one opening, and at the Moore Dam in southern Vermont, to control three large bays, where the steel WF sections are called "needles" and are about 10m. high. Due to the large forces imposed by the needles, the top release mechanism has two stages wherein the top of a pinned hook is released by extracting the pin, the hook then rotates on a lower hinge and releases the needle.

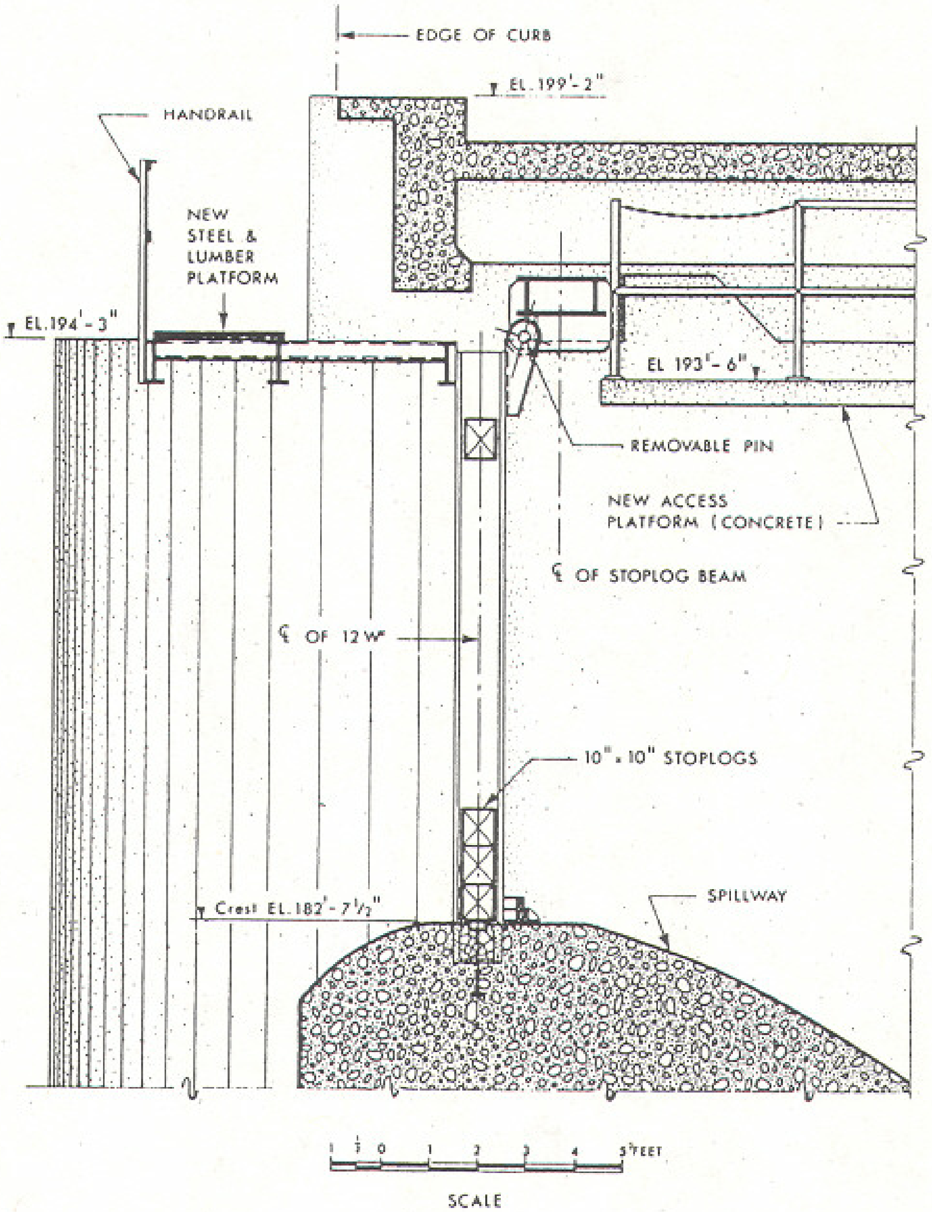

FIGURE 3

DETAIL OF STOPLOG RELEASE MECHANISM

<u>BEARSPAW</u>

The Bearspaw power development on the Bow River, just upstream of Calgary, was commissioned in 1954. The development includes a 3-gated spillway with a flow capacity of 2832 cumecs (100,000 cfs.). The gates are lifted by double screw stem hoists. The gates are 15.2m. wide by 9.6m. high.

To the north of the spillway there is a 17MW single unit powerplant, followed by a 20m. high earth fill dam. The main transcontinental line for the Canadian Pacific Railway follows the north abutment only a few meters above the reservoir level, as shown on Figure 4 below.

Flood studies indicated that the probable maximum flood would have a peak flow of 6145 cumecs, which would require increasing the spill capacity by 117%. This capacity increase was obtained by allowing the reservoir level to increase to EL 1094.23m. at PMF, or to 3.05m. above the winter full supply level, and to the level of the CPR tracks, combined with the addition of a new side channel weir spillway. At the higher reservoir level, the capacity of the existing spillway is increased to 4276 cumecs, and the new spillway has a capacity of 1869 cumecs.

To acommodate the higher reservoir level, the concrete spillway peirs were raised and the level of the hoist platform was increased so that with new longer screw stems, the gatescan be lifted 1m. clear of the flood waters. The spillway was model studied, and as a result, the stilling basin was extended by 12m. and the concrete was securely anchored to the underlying rock. The stability of the piers was also improved with rock anchors. The earth dam crest was raised by 1.2m. and waterproofed to crest level with an impermeable membrane embedded in bentonite.

The only possible location for a new spillway was adjacent to the left bank, and a study of several alternatives indicated two as being the most attractive, a

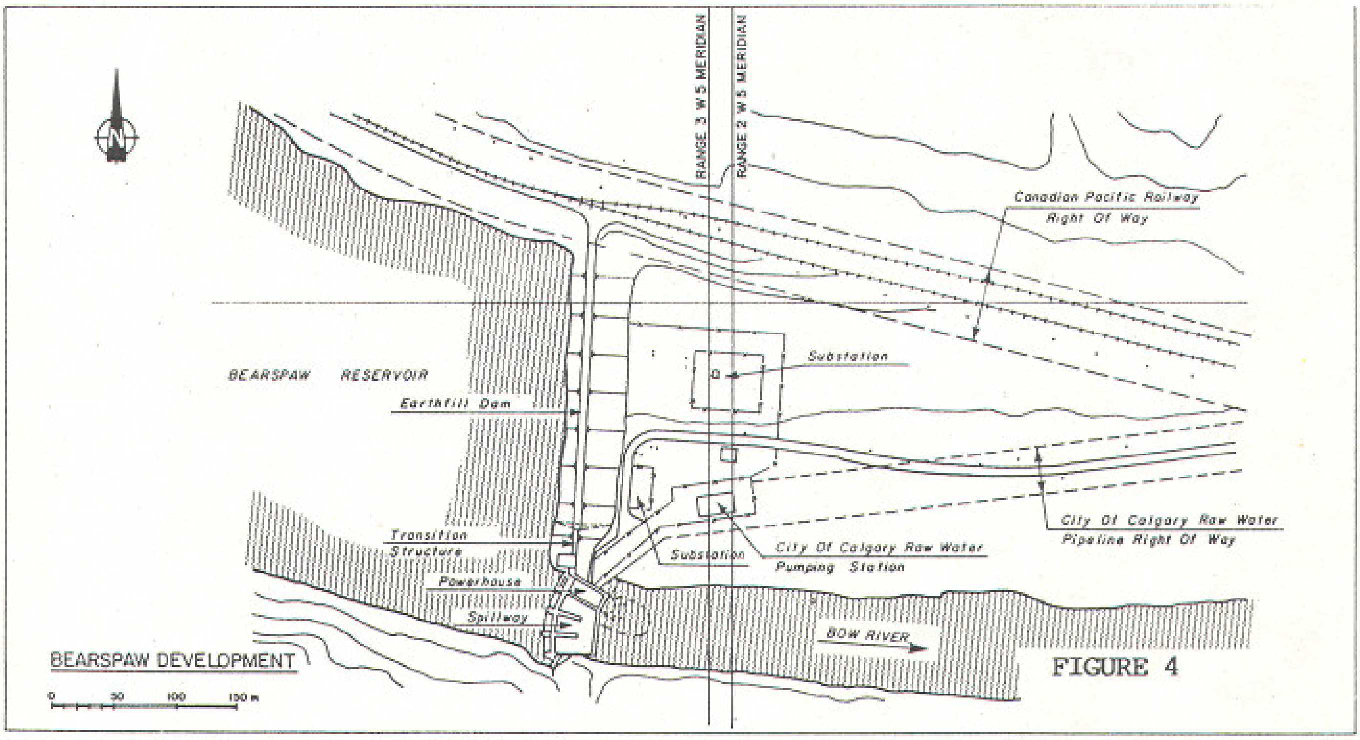

FIGURE 4

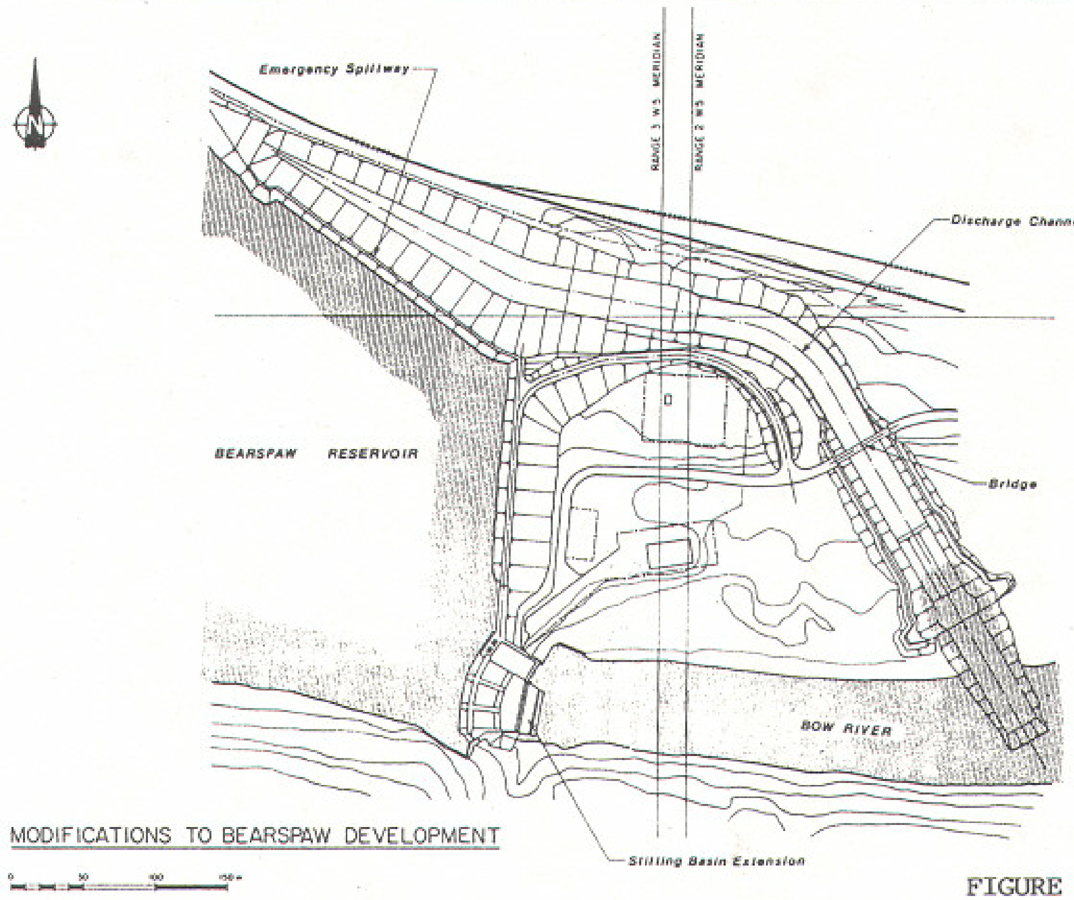

FIGURE 5

three-gated spillway, and a long side channel overflow weir spillway. The latter was selected due to a 25% cost advantage, and more reliability.

The concrete weir has a length of 215m., and discharges into an expanding sloping downward concrete lined channel, with the lining terminating 60m. downstream of the dam centerline, as shown on Figures 5 and 6. The channel continues in rock cut to below the access bridge, after which it is lined with heavy rip-rap. With no right angles in the concrete lining, the design and drafting was greatly simplified by the use of CAD.

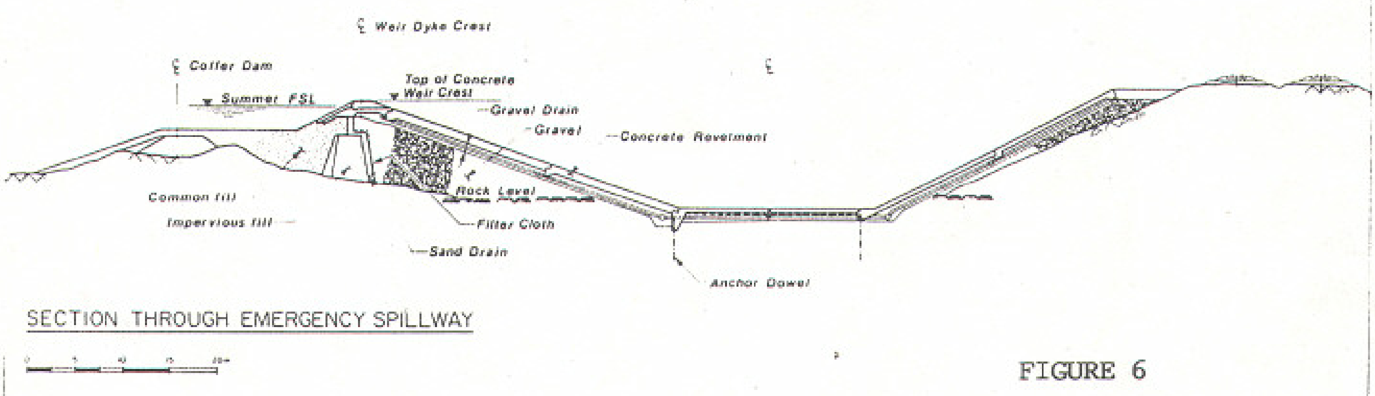

FIGURE 6

GHOST DAM

The Ghost Dam was commissioned in 1929. It is located at the confluence of the Ghost and Bow rivers, 33km. west of Calgary. There were two stoplog controlled spillways, a main spillway in the south river channel, and an auxiliary spillway immediately north of the powerplant as shown on Figure 7 below. The total capacity of the two spillways was theoretically 3160 cumecs, but the considered safe discharge capacity was much lower due to the lack of energy dissipators.

The PMF peak was estimated at 5270 cumecs, and this flow would have to be passed at the dam since the reservoir was small. The increased capacity was obtained by re-building the 6-stoplog auxiliary spillway into an 8-gated main spillway with a flip bucket, and closing off the old main spillway with a weir having a crest at normal FSL. When the reservoir rises 2.4m. at maximum flood, the weir will discharge 570 cumecs, which is considered to be the safe discharge capacity of the south channel.

The main spillway is now built into the concrete dam to the north of the powerhouse, which has a height of 34m. and a crest length of 285m. The shape of the new spillway was obtained from a hydraulic model study undertaken in Vancouver. The new spillway has 2 large gates in the middle, flanked on each side with 3 smaller gates. The different gate widths were required to avoid building piers above existing expansion joints. Gated spill capacity is 4700 cumecs.

The most difficult task was devising an unwatering scheme for the new spillway gates. This required demolition of concrete down to EL 1181.0m. but the reservoir could not be drawn down below EL 1182.62m. the lowest level for operation of the turbines. The problem was solved by using a pre-fabricated steel pier nose form attached to the concrete, behind which concrete was demolished and the new piers poured. When 2 adjacent piers were completed, a second steel form bulkhead was used combined with 2 steel stoplogs to form a cofferdam between the piers all as shown on Figure 8 on the following page.

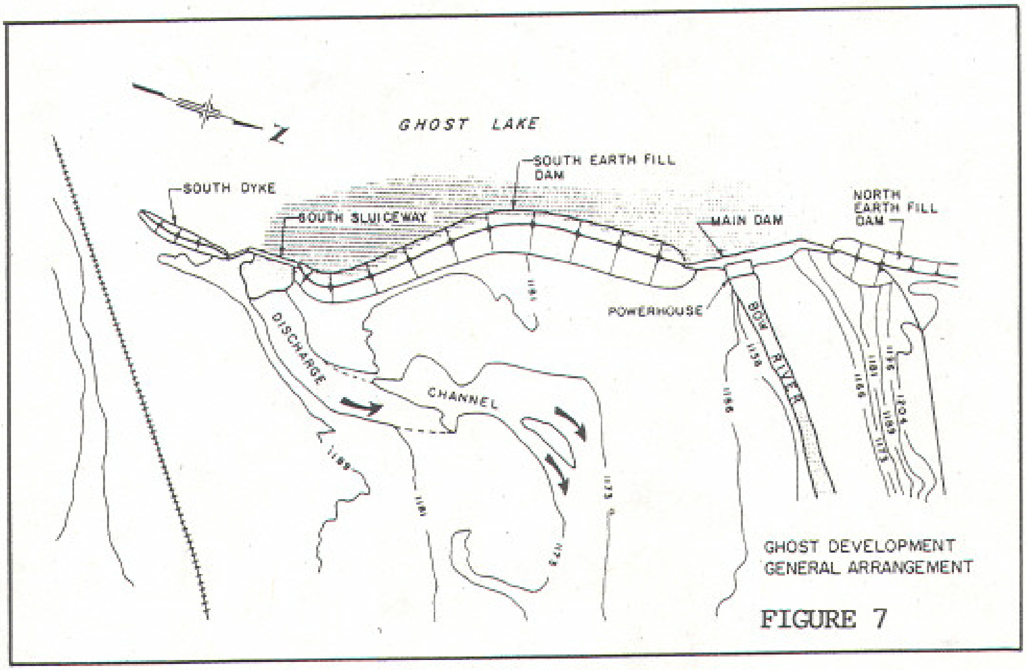

FIGURE 7

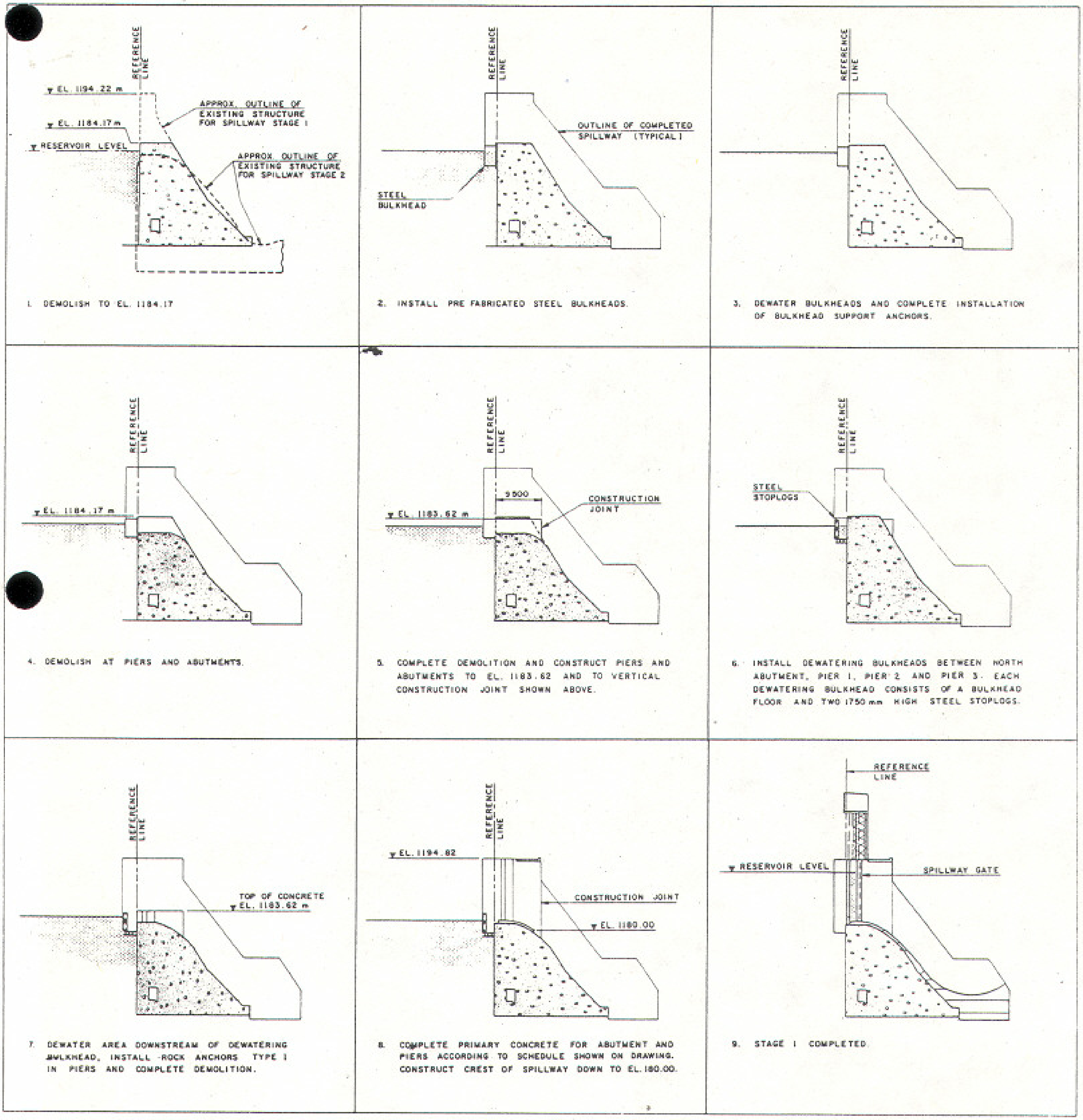

FIGURE 8

SCHEMATIC SHOWING UNWATERING FOR SPILLWAY

Soft neoprene pads of various thickness were used to provide a seal between the steel cofferdam and the rough concrete face of the dam. Seepage was minimal and was easily handled with a 4" pump.

Two other modifications were made to the development. Mass concrete was added to the dam to improve stability, and the dam crest was raised 6ft to EL 1194.22m., which is the crest level of the earth dam. In the original development, the crest of the concrete dam at the powerhouse and at the auxiliary spillway was 6 feet lower than the earth dam crest, so that it could act as a last chance emergency spillway. All work was completed in 1989.

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ACKNOWLEDGEMENT

All figures have been photocopied from the above referenced publications.