

Manitoba Hydro

Seven Sisters Generating Station



Seven Sisters Generating Station is Manitoba Hydro's largest producer of electricity on the Winnipeg River in southeastern Manitoba. Located about 90 kilometres (km) eastwards of the City of Winnipeg, it is fondly and respectfully described by engineers who designed and built it as the river's mightiest generating station.

The generating station operates at a maximum capability of 153 megawatts (MW) and can produce, when water conditions are ideal, an average of about 990 million kilowatt-hours (kW·h) of electricity per average year.

Seven Sisters, which is about 72 km from Lake Winnipeg, was built in two stages. The first stage, begun in July 1929, featured the construction of a powerhouse. When completed in August 1931, it housed the first three of six turbine generators (called units) which produced a total of 75 MW.

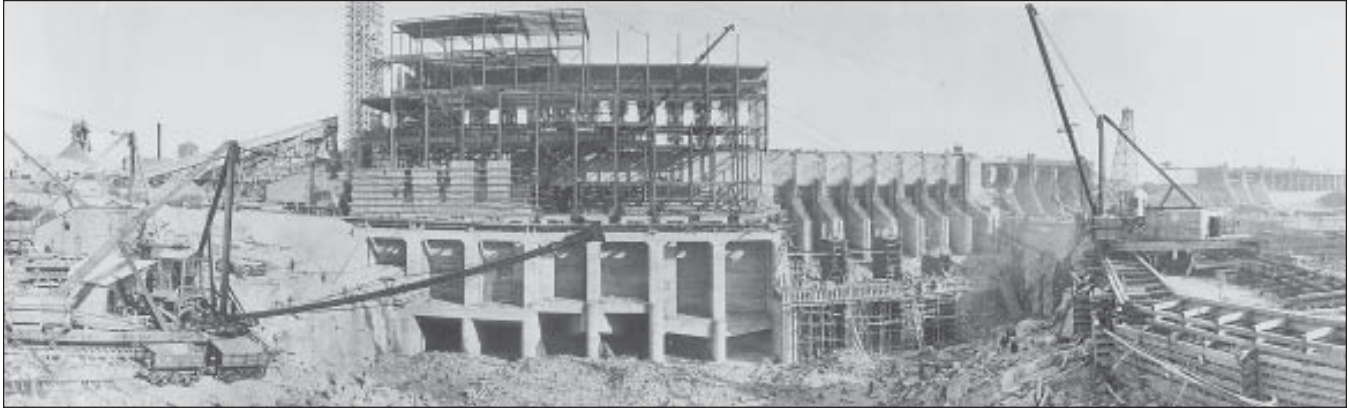
Stage two began later, in 1948, three years after World War II had ended. Inevitably, the war had delayed progress in the province's development, but during that time the demands for electricity had increased and two more units were installed at Seven Sisters. In 1952, the sixth and final unit was placed in service. These additional units doubled the generating station's total megawatt production.

Seven Sisters is a "run-of-river" design, which means that water flowing into the generating station from upstream is used immediately, not stored in the forebay for later use. The spillway at Seven Sisters is flanked to the north and south by non-overflow, concrete wingwalls. The powerhouse is incorporated into the north wingwall. Because the water level in the generating station's forebay is higher than ground level, dykes have

been built for 5.6 km upstream on the Winnipeg River's north shore and 7.2 km upstream on the south shore. They are constructed with a clay core and are covered with varying sizes of rock.

The forebay (a reservoir which stores vast quantities of water upstream of the generating station) creates Natalie Lake, which is 11 km long, and between 0.8 km and 2.4 km wide.

When water from the forebay enters the units at Seven Sisters and is then discharged into the tailrace (the river immediately downstream of the generating station), the water level has dropped 20 m. This drop, or fall, is described as the operating head. Energy contained in falling water is converted into mechanical energy, which in turn is converted into electrical energy.



The construction of a generating station is an enormous task that takes many years of planning and building. Thousands of workers were involved in building the Seven Sisters dam during stage one in the late 1920s and early 1930s.

“Progress consists in lifting the burden of drudgery from tired human shoulders to the tireless shoulders of the dynamo. Every loafing stream is loafing at the public’s expense. Every added kilowatt means less work for someone and more freedom for everyone — a richer change of life.”

— *General Electric Company president, Owen D. Young, when visiting Seven Sisters in 1927.*

During high flows, the fore bay’s water level is regulated by the spillway structure using gates and stop logs. Water can be discharged through its 28 openings, each of which are about 6 m wide. Water is only spilled at times when too much has accumulated in the Winnipeg River. This may happen during spring run-off if the winter’s snowfall has been heavy or following major rainstorms.

Seven Sisters has a daytime staff of control room operators and maintenance people. When first built, the staff, who lived in the Manitoba Hydro townsite beside the generating station, worked in shifts to run Seven Sisters 24 hours a day. But since remote control equipment was installed in 1970 linking the generating station to Manitoba Hydro’s System Control Centre in Winnipeg, the generating station’s employees work a daytime shift only. Upgrades to equipment and technology will allow Seven Sisters to be monitored at Great Falls Generating Station, as will all Manitoba Hydro’s generating stations on the Winnipeg River.

Rapids’ energy converted to electrical energy

Early travellers on the Winnipeg River encountered a hazardous stretch of white water for 11 km along the extreme southwest bend of the river’s main channel. From the time of voyageur Sieur Pierre de la Verendrye in the early 1700s until about 1910, this stretch of the river was known as Seven Portages due to its seven rapids — rapids that were later consolidated into one big waterfall for operating Seven Sisters Generating Station when it was built in 1929.

Before Seven Sisters was built where the rapids cascaded, interest in developing the site was expressed by power planners as early as 1903, when the Winnipeg Electric Street Railway Company acquired title to the land next to the rapids. This title permitted the company to construct a diversion dam across the river at the foot of the rapids — a dam which would regulate the river flow in a way that would allow a generating station, the one eventually called Pinawa, to operate 5.6 km further upstream.

By 1915, investigations by engineers concluded that the seven rapids would support two generating stations — one harnessing two rapids upstream, and one harnessing five rapids downstream. However, it was eventually decided to build only one, after Great Falls Generating Station had been built further downstream in 1923. Pinawa, which dammed a channel of the Winnipeg River and not its main stream, was shut down in 1951 and the water flowing through it was returned back into the river's main channel where it could be used to generate many more megawatts at the new Seven Sisters Generating Station. Building only one station was, in the end, more efficient, halved the capital costs, and reduced the costs for operating three stations (Pinawa plus two new ones harnessing the seven rapids).

Rehabilitation of Seven Sisters

When Seven Sisters had reached 50 years of age in 1979, a major six-year rehabilitation project was conducted to extend its productive life another 50 years. Manitoba's winter with its freeze-thaw phenomenon had caused serious concrete deterioration and it became necessary to repair the generating station's north dam, to build a concrete structure to link the powerhouse to the north dyke, and to repair the powerhouse, spillway and sluiceway structures. In the late 1980s, the station's electrical and mechanical equipment was also upgraded.

Rehabilitating a large structure like Seven Sisters while it continued to produce electricity was a major challenge. The generating station's north non-overflow dam in particular was in critical shape, and engineers were concerned about the pressure of the huge volume of water in the forebay on the weakened structure. Before the difficult task of repairing the north dam began, therefore, the forebay's water level was lowered by 1.1 m to relieve stress — a level that



Rock-filled cribs were placed in the river to form a wall around the area to be drained dry. This area, called a cofferdam, is where the Seven Sisters Generating Station was eventually built.



Workers built the generating station with the Winnipeg River's turbulent waters rushing close by.

was maintained for about three years. Even so, repair workers toiled behind a formidable head of water of more than 18 m.

Over the years it was found that 15 of the spillway and sluiceway piers needed replacing and the rest resurfacing. During the three years of lower water levels, a portion of the 225-m-long structure was kept operational in case excess water had to be spilled, or in case the powerhouse was shut down during an emergency.

In the 1990s, many upgrades have taken place and will continue during the 2000s. Upgrades include the re-running of turbines and the rewinding of generators to allow increased production of electricity. New excitation and voltage control systems have also been installed to complement the upgrade of the generators. This will enable them to run either in generation mode or in synchronous condenser mode, which allows generators to operate as a motor during low water conditions, thus reserving the water for future use.

The technology of the turbine generators which convert water energy to electrical energy has not changed a great deal, though the scene within the powerhouse has. However, with Manitoba Hydro's ongoing program to modify the turbine generators, their output and efficiency has increased in recent years.



The powerhouse in the 1930s.

Seven Sisters Generating Station facts

Construction started	1929
Construction completed	1952
Capability	Approximately 153 MW
Average annual generation	990 million kW·h
Waterfall drop	18.6 m
Powerhouse	Length: 128 m
Number of turbine generators (units)	6 (units 1-3 turn at 138.5 rpm, units 4-6 at 128.6 rpm)
First unit in service	1931
Production of units	Approximately 26 MW each
Units' discharge capacity	1 146 m ³ /s of water
Forebay area	21 km ²
Forebay's normal water level	274.2 m
Spillway	Length: 225 m (Seven Sisters has two spillways with 27 bays, divided by a sluiceway with 2 bays)
Spillway's discharge capacity	1 030 m ³ /s of water
Transmission lines	Seven 115 kV (five to Winnipeg, one each to Whiteshell area and Kenora, Ontario)

Major contractors

Generators	Canadian General Electric
Turbines	Allis Chalmers, S. Morgan Smith, Dominion Engineering



The powerhouse in the 1990s.

For more information contact:
 Public Affairs
 Manitoba Hydro
 P.O. Box 815
 Winnipeg MB
 R3C 2P4
 (204) 474-3233

