Manitoba Hydro

Limestone Generating Station

Limestone is Manitoba Hydro's fifth and newest generating station built on the Nelson River in northern Manitoba. It is also the largest in the province. Its 10 turbine generators (called units) have the capability of generating 1,340 megawatts (MW) of electricity.

Limestone is located 750 kilometres (km) north of Winnipeg and 260 km south of the northern town of Churchill. Sitting on the lower arm of the Nelson River, the station is 23 km downstream from Long Spruce Generating Station, which in turn is 18 km downstream from Kettle Generating Station.

The first of Limestone's 10 units began producing power in September 1990. About one year later, the generating station was officially opened when five units were in operation. Then, in September 1992, just two years after the first unit began production, the final unit went into service.

Construction of Limestone Generating Station was completed ahead of schedule and well below budget. Worldwide, only two per cent of projects of this magnitude accomplish such a feat. Limestone's total cost was approximately $1.43 billion. Lower interest rates and lower than anticipated escalation costs helped keep the project under budget.

Work at the Limestone site first began in 1976, when the largest cofferdam ever seen in Manitoba was built. The cofferdam, a temporary, watertight, island-like enclosure where the proposed powerhouse and spillway structures were to stand, took two years to complete. It was 20 meters (m) high to prevent flooding – which could be caused either by ice jamming in the river during the winter or by water levels exceeding the river's average level of 15 m during the summer. Extending about two-thirds of the way across the Nelson River, the cofferdam had the water pumped out of it to create the dry conditions for building the generating station. Meanwhile, the river's natural water flows continued past the cofferdam via the open channel in the remaining one-third.

When the cofferdam was completed in 1978, the decision was made to suspend the Limestone project, based upon a dramatic reduction in the expected demands for electricity. It wasn't until 1985 that the major construction work started up again.

Working from April to November only during 1986 and 1987, approximately 75 per cent of the total concrete required for Limestone was placed. For the first time in North America, a newly developed piece of equipment (inset) – a large, flexible hose – was used for pouring and placing concrete.

The powerhouse and spillway

Limestone Generating Station is a "run-of-river" design (meaning that water arriving from upstream is used immediately, and not stored in the forebay for later use), which makes the most efficient use of the natural elements of the river. Limestone's forebay – the reservoir upstream of the generating station that creates the waterfall – is almost entirely contained within the natural riverbanks, minimizing the need for extensive dyking.

Limestone's design also takes into account the operation and maintenance of the generating station under very severe northern climate conditions.

The powerhouse of a generating station houses the units that generate electricity. Limestone's 10 units, which are of the vertical shaft, fixed-blade propeller type, have a total capability of 1,340 MW, and, when water conditions are ideal, can produce over 8,500 million kW.h of electricity per year. In comparison, one of these units produces more than the total capacity of the six units at the 75-year-old Great Falls Generating Station on the Winnipeg River, which has a capacity of 131 MW.

Limestone's powerhouse is coupled directly to the intake structure, which allows the water to flow in to turn the generating station's huge turbine runners. Limestone's spillway helps to control the water level in the forebay. The operating head, which is a waterfall created by the generating station's structure, is 27.6 m.

The powerhouse measures 56.5 m by 299 m – three times the length of a football field. It is designed for a water flow of 5,100 cubic metres per second (m^3/s). The flow of water through the powerhouse is controlled by 30 intake gates. Each unit has three, each measuring 5.5 m wide by 14 m high and weighing about 78 tonnes (t).

Limestone's overflow spillway is 119 m wide and 112.5 m long. It has

seven gates, each measuring 13 m wide by 16 m high. Three of the gates are designated as high head gates, designed for a maximum operating head of 33.3 m. The other four gates are designated as low head gates, designed to operate under a maximum operating head of 14 m.

About 650,000 m^3 of concrete were used to build Limestone – equivalent to the amount of concrete needed to build a sidewalk 12,800 km long (that's one-third of the way around the world), or enough concrete to provide a basement for every house in a city the size of Brandon. In addition, 142,000 t of cement and 33,000 t of reinforcing steel were required to construct the massive structures that made up Limestone Generating Station.

The dams and dyke

Earthfill dams connect Limestone's concrete structures to the Nelson River's north and south banks. The total length of the dams and structures is approximately 1,300 m. A dyke, ranging from three to six metres in height, also extends from the north earthfill dam for a distance of 570 m along the riverbank. This dyke forms part of the forebay's containment. The total amount of material in the dams and the dyke is 2,900,000 m^3.

The total volume of fill required for the various phases of cofferdam construction was 3,500,000 m^3. The excavation of 3,200,000 m^3 of rock within Limestone's cofferdams was necessary at the locations where the powerhouse and south dam would stand.

Limestone and the environment

Environmental planning was incorporated into every aspect of the Limestone construction project. Manitoba Hydro's environmental inspection program plus the Department of Natural Resources' inspection-enforcement function ensured compliance with the province's environmental regulations and commitments. Environmental education and information programs were also provided for the staff involved in the Limestone development as well as for the local residents.

The main environmental concern associated with the project was the potential impact on brook trout, which are considered a heritage species in Manitoba. Since Limestone has been in operation, the monitoring of this and other fish species and habitats indicates that it has had little negative effect on aquatic resources. The forebay created by the generating station provides additional habitat for several species, and the reclamation of areas impacted by the development has enabled the recovery of some depleted trout stocks.

The sites disturbed by the construction activities (such as roads, work sites, gravel pits) and by previous activities (such as stream crossings and ditches, exploration trails, construction sites) were rehabilitated to create a productive habitat. More than 81 hectares of disturbed lands were seeded to grass, to both initiate revegetation and prevent soil erosion. And eroding slopes and stream banks were stabilized to prevent any further degradation of fish habitat. Other remedial work, such as cleaning up the sites and disposing of debris, was also an important part of the environmental plan.

An upper generator bracket is installed in one of Limestone's turbine generators (units).

The Nelson River HVDC transmission system

For transmitting south, the alternating current (AC) electricity generated at Limestone is converted to direct current (DC) electricity at Henday Converter Station. DC transmission is a more efficient and economical method of carrying electricity over long distances.

Located within a kilometre of Limestone, Henday also converts half of the power produced at Long Spruce Generating Station. The

electricity is transmitted along about 900 km of high voltage direct current (HVDC) transmission lines, which run south through the Interlake region to Dorsey Converter Station at Rosser, located about 26 km northwest of Winnipeg. At Dorsey, the DC electricity is converted back to AC for supplying customers via Manitoba Hydro's 230 kV transmission line system.

The Nelson River

The Nelson River was discovered and named by Sir Thomas Button in 1612. Button was searching the Hudson Bay area for the missing explorer Henry Hudson, who allegedly had been marooned by mutineers in 1610 when he was on an expedition in search of the northwest passage to the Orient. After a futile search, Button's return to England was blocked by the sudden approach of winter and he and his crew had to spend the season stranded at the mouth of an unknown river. During this forced stopover, he named the river in honour of Francis Nelson, his sailing master who had died during the voyage from England to Hudson Bay.

About 60 years later, the Nelson River played a vital role in the rich fur trade. Britain and France were fighting fiercely for control of the mighty Nelson – which was the main route into the heart of western Canada, and was regularly traveled by missionaries, explorers and settlers. However, the river had many long stretches of rapids, and pilots of the York boats dreaded the long portages facing them and preferred to travel via the Hayes River.

The long stretches of rapids that frustrated the pilots would, centuries later, delight power planners. In the year 1910, 300 years after the disappearance of Henry Hudson, the first reconnaissance was carried out to examine the resources of the Nelson River.

The 656-km long Nelson flows in a northeasterly direction into Hudson Bay. Starting from its headwaters in the northeast corner of Lake Winnipeg, the river descends about 217 m in a series of falls and rapids before it enters the bay. Although the Nelson itself is entirely contained within Manitoba, it is fed by a huge drainage basin that stretches from the foothills of the Canadian Rocky Mountains to within 19 km of Lake Superior. It is a rich source of hydroelectric power in Manitoba.

Today, Limestone Generating Station harnesses the power of the Nelson River along with four other generating stations - Kelsey (first unit in service 1960, capability 225 MW), Kettle (1971, 1,220 MW), Long Spruce (1977, 1,010 MW), and Jenpeg (1979, 131 MW).

Limestone Generating Station facts

Construction started	1985
Construction completed	1990
Cost	$1.43 billion
Capability	1,340 MW
Average annual generation	7, 640 million KW·h
Waterfall drop	27.6 m
Powerhouse	Length: 299 m
Number of turbine generators (units)	10 (each turns at 90 rpm)
First and 10th units in service	September 1990, September 1992
Production of units	About 130 MW each
Units' discharge capability	5,100 m3/s of water
Forebay area	27.1 km2
Forebay's normal water level	85.3 m
Spillway with 7 gates	Length: 112.5 m
Spillway discharge capability	9,570 m3/s of water
Transmission lines	230-kV AC to Henday Converter Station, 500-kV DC to Winnipeg

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