CONSIDERATIONS FOR SITING
A NUCLEAR POWERED GENERATING STATION
IN SASKATCHEWAN

March 20, 1975

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SASKATCHEWAN POWER CORPORATION

TO E. R. Smith,	FROM P. G. Sundeen,
Department Planning & Engineering,	Department Technical Planning,
Location Regina,	Date April 4, 1975.

Subject:

Nuclear Generating Location

Attached is a preliminary report on possible site locations of a Nuclear power plant in Saskatchewan. Please advise if you wish any further work on this at the present time.

PGS/sl

Technical Planning Manager.

SASK. POWER CORPORATION
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R. W. Nordquist.

Introduction

The electrical energy load growth forecast for Saskatchewan indicates that a nuclear reactor power plant would be a viable source of energy in the late 1980's.

The minimum economical size reactor presently considered is 600MW.

This report considers that siting of a nuclear plant somewhere in Saskatchewan in the period 1985 to 1990 is a practical and possible development.

A 1000MW capacity plant is used in this report. Other sizes can be simply pro-rated to suit.

An adequate cooling water supply is the single most important consideration and the majority of the report will deal with this aspect. Other considerations for siting are included as a matter of interest now, but cannot be ignored in final site location.

1. CONSIDERATIONS FOR SITING A 1000MW NUCLEAR-POWERED ELECTRICAL GENERATING STATION

1.1 Cooling Water Requirements

The cooling water circulating rate for a 1000MW nuclear plant is 592,000 Igpm at 24°F temperature rise(1) at 80% L.F., also, 592,000 Igpm is equivalent to 1,579 cfs.

1.2 Straight-Through or Once-Through Cooling System

Cooling water is withdrawn from a water source such as a river, pumped through the condenser and discharged directly to the same river. If the present stipulation of a 3°C or 5.4°F temperature change in a water body is considered, then a steady river flow of 7,000 cfs is required for adequate cooling. This flow rate is higher than the minimum flows in any Saskatchewan rivers with the exceptions of the eastern portions of the Churchill River and the Fond du Lac River nearing its entrance to Lake Athabasca. 7

1.3 Evaporative Cooling Systems

The Evaporative Cooling Systems are basically closed systems wherein the circulating water is cooled by a combination of evaporative, radient, convective, and conductive cooling. Water must be added to the systems to make up for the quantity of water lost to the atmosphere in the cooling process.

1.3.1 The first common evaporative cooling system for a large power plant utilizes a reservoir that has the following minimum criteria. 1.6 acres of surface area per MW output(2) and a water supply of 9.6 acre feet per year per MW of output(3). If the reservoir is an existing lake or pond, the natural evaporation is not a chargeable water use. The creation of a new reservoir requires a minimum water supply of an additional 3 acre feet per acre of surface area per year.

The data for a 1000MW plant -

Utilizing an existing lake - Surface area 1600 acres min.
Water supply 9600 acre feet per year

Constructing a new reservoir - Surface area 1600 acres min.
Water supply 14400 acre feet per year

1.3.2 The second evaporative cooling method uses cooling towers to cool the circulating water as a completely closed cycle, or to augment the cooling of a straight through method by simply lowering the water temperature to within acceptable limits before returning it to its source such as a river or stream. The water requirements for a 1000 MW plant using cooling towers is 20,000 acre feet per year.

1.3.3 There has been no allowance made for the lowering of the concentration of solids that the evaporative processes develop but doubling of the previously stated water requirements would be adequate.

2. OTHER CONSIDERATIONS IN SITING A NUCLEAR POWERPLANT

Nuclear powerplant sites are chosen for other reasons than the cooling water supply. These reasons are listed and briefly described.

2.1 Transmission distance to the expected load, the relative distance of plant site to load, cost of right-of-ways and cost of construction which would depend to a large extent on the intervening topography.

2.2 Availability of an adequate supply of labour both for construction and operations. A close proximity to a large city is usually beneficial in this respect.

2.3 Access to the site by road, rail and other services or utilities. Fortunately, in Saskatchewan the electrical loads are in the more developed areas. The capital costs of railroad construction are high and are only required during construction.

2.4 Foundation materials - for a Saskatchewan Southern area foundation materials are assumed to be generally the same, being of glacial drift with only minor local differences.

2.5 Seismic activity as in 2.4 - all areas of Southern Saskatchewan can be assumed equal.

2.6 Safety of the environment - plants should be in lightly populated areas that would allow evacuation in case of emergency or specially equipped to lessen the chances of an emergency arising.

Treatment and disposal of plant wastes, sewage, circulating water, and ventilating air are required.

2.7 Direction of prevailing winds - ventilating air is exhausted to a tall stack for dispersal with atmosphere.

2.8 Access to major centres as a source of supply for goods and services required for construction and operation.

2.9 Aesthetics of plant location and structures should be considered in site planning as to whether structures can be hidden or blended in with the surroundings.

2.10 Consideration of possible beneficial uses that new roads, reservoir, community, etc., may have for recreation, flood control or irrigation and as a source of employment.

2.11 It is noted in the Saskmont report that licensing of nuclear plants is done by the Atomic Energy Control Board and can be a long, tedious process unless a proven design is used. If a proven design is used and the Board normally does the reactor design, then the only problem is in actual plant location and in which case sites are submitted to the Board and they will approve or disprove based on comprehensive data that must be submitted with the site proposals.

3. PLANT SITING

3.1 In Southern Saskatchewan the supply of cooling water is usually of utmost importance, second only to the fuel supply. A nuclear plant fuel supply is of relatively minor importance so a plant site can be optimized to obtain the best cooling water supply and be close to the loads served.

3.2 The load centre is apparently midway between Regina and Saskatoon and slightly to the east.

3.3 There are several obvious sources of water in this general area, the major ones being Last Mountain Lake, Diefenbaker Lake and the South Saskatchewan River. Other less obvious ones should be examined because they could have features that would make them attractive.

3.4 An example could be a site in the Moose Jaw Creek area. A reservoir could be constructed by damming Moose Jaw Creek south and upstream of the City of Moose Jaw. The water supply available is limited but adequate. Flood control could be a major benefit. A labour supply would be readily available. The prevailing wind direction is acceptable. Waste disposal would be a problem and transmission distances are moderate.

3.5 Site locations - as an aid in site location, a table has been prepared listing possible sites and considerations to be weighed in the site selection. The various factors were listed and for the sake of comparison numerical values were assigned. The values were arbitrarily selected for each factor and rated on a scale of 1 to 10 with the lower numerical value indicating the higher quality or lower cost. Therefore, the most desirable or highest ranking site would have the lowest sum or total rating.

The ranking in the table shows the site on the South Saskatchewan River as being equivalent to the Diefenbaker Lake site. There was insufficient weight assigned to the cost of the cooling water supply that causes this result. Note that the six highest ranking sites don't have a wide spread in numerical values. A more logical ranking would appear as:

TABLE I

Site	Cooling Water Supply	Access to Load Centre	Other Beneficial Uses	Site Access	Access to Major Centres	Labour Supply	Seismic Activity	Foundation Materials	Safety	Prevail. Wind	Waste Discharge	Total Rating	Rank
North side - Qu'Appelle Valley	6	4	8	3	6	8	5	5	7	8	10	70	8
South side - Qu'Appelle Valley	6	5	8	3	6	6	5	5	7	8	10	69	7
Last Mtn. Lake													
- East side	4	2	7	6	7	6	5	5	6	2	6	56	2
- West side	4	1	7	6	7	8			6	2	6	57	3
Diefenbaker Lake													
- near Dam	3	7	8	4	6	7	5	5	5	2	3	55	4
- remote from Dam	3	3	6	5	8	7	5	5	3	2	3	50	1
North Sask. River	5	9	5	7	3	5	5	5	7	7	1	59	5
South Sask. River	5	6	5	7	3	3	5	5	6	4	1	50	1
Moose Jaw Creek	10	8	5	5	3	3	5	5	6	4	8	62	6
Black Strap Lake	9	5	10	7	3	3	5	5	10	4	10	71	9

1. Diefenbaker Lake - remote from the dam, east side preferably
2. South Saskatchewan River - south of Saskatoon
3. Last Mountain Lake - east side
4. Last Mountain Lake - west side
5. Diefenbaker Lake - near dam
6. North Saskatchewan River - north of Saskatoon
7. Moose Jaw Creek - south of Moose Jaw
8. Qu'Appelle Valley - south side
9. Qu'Appelle Valley - north side
10. Black Strap Lake - any location

3.6 It would seem that three of the best alternatives should be considered for further study, these are:

(1) Diefenbaker Lake
(2) South Saskatchewan River
(3) Last Mountain Lake

A more detailed examination of the alternatives in which advantages and disadvantages either real or assumed are listed indicates that a Diefenbaker Lake site would be the best.

Diefenbaker Lake Site

Advantages:	Disadvantages:
(1) A large water body that will tolerate a large heat load.	(1) The large drawdown (30 ft.) would require a more expensive intake structure than Last Mountain Lake.
(2) A large water body that will allow dilution of wastes before reaching a major domestic water supply.	(2) Radioactive waste may not be acceptable in irrigation water.
(3) Remote from a large population that may have to be evacuated in an emergency.	(3) Not as close to load centre as Last Mountain Lake.
(4) Good rail and road access.	
(5) Not fully developed as a resort area at this time.	
(6) A complex cooling water return should not be required as the Lake has a high circulation volume.	
(7) There may be some advantage in warming the Lake water.	

South Saskatchewan River

Advantages:

(1) Adequate water supply of flowing water to allow dilution of wastes.

(2) This site could be located on the River anywhere between Saskatoon and The Gardiner Dam. Siting close to Saskatoon benefits the labour supply. Close to the Dam benefits the transmission distance and dilution and mixing of wastes.

(3) Temperature of return water to the River can be rigidly controlled.

Disadvantages:

(1) Highest cost cooling water supply as it will require remote cooling ponds or cooling towers.

(2) Farthest from load centre.

(3) Road and rail access depend on actual site chosen - good at either extremity and poor in the central reaches of the river.

(4) Special construction safety features are required if a plant is built very close to a major centre.

(5) Highest chargeable water use.

Last Mountain Lake

Advantages:

(1) Probably the cheapest cooling water supply in regard to intake structure.

(2) Closest site to geographic load centre.

(3) Road access is good.

(4) Water supply adequate and could be supplemented by existing diversion practices via the Qu'Appelle River and the South Saskatchewan River.

Disadvantages:

(1) Heat load may be unacceptable to the relatively shallow northern end of the Lake and special mixing facilities would be required.

(2) The Lake is relatively a popular resort area.

(3) Waste would not receive the dilution that could be obtained on the other two sites.

(4) Depending on exact location, rail access is not the best.

4. RECOMMENDATIONS

There are several suitable sites available for a nuclear plant close to the load centre of the Province. It may not be premature to tentatively select a site or sites for further study. If sites are selected soon, then future developments such as resort areas in the immediate vicinity could be discouraged. It could be beneficial to instigate some discussions with the Department of the Environment as to long-range planning for the use of the water resource and environmental considerations.

(1) Pro-rated from Saskmont Engineering Report of May, 1973.
(2) A nuclear plant requires 60% more cooling water than a thermal plant (Ref. 1)
(3) Pro-rated from B. Hamilton's Report "Coronach Reservoir with two 300MW Units"