

PRAIRIE PROVINCES WATER BOARD

Report #4

COMPARISON OF
TWO ALTERNATE DEVELOPMENTS
IN SASKATCHEWAN RIVER BASIN

413 Post Office Building,
Regina, Saskatchewan,
October, 1951.

COMPARISON OF ALTERNATE DEVELOPMENTS IN THE
SASKATCHEWAN RIVER BASIN

There are many alternate developments that could be constructed to utilize the waters of the Saskatchewan River Basin. This report, however, will be confined to comparing two proposals, one of which is capable of extension along two different lines. These proposals are:

#1. North Saskatchewan Irrigation Project - envisages the irrigation of more than 800,000 acres in both Alberta and Saskatchewan by utilizing the waters of the Red Deer River together with water diverted from the Clearwater and North Saskatchewan Rivers.

#2. Separate Projects (Intermediate Stage) - envisages the irrigation of some 350,000 acres in Alberta using the Red Deer River plus water diverted from the Clearwater River (see S. H. Hawkins P.F.R.A. Report of 1947), together with the independent South Saskatchewan River Project which utilizes the waters of the South Saskatchewan River (see P.F.R.A. Summary Report of April 1951).

#2A. Separate Projects (Alternate Final Stage) - same as #2 plus the diversion of additional water from the North Saskatchewan River into the Red Deer River to be used to produce additional hydroenergy.

#2B. Separate Projects (Alternate Final Stage) - same as #2 plus the diversion of North Saskatchewan River water to be used for (a) irrigating an additional 250,000 acres through the Red Deer Project and (b) produce additional hydroenergy.

See Figures 1, 2 and 3 for maps of these proposals.

Purpose of Study

This study has had as its object the determination of the physical results of these alternatives as expressed in acres irrigated, kilowatt hours produced and dollars.

Results of Study

This study indicates that, for the assumptions used herein, the final stages of proposal #2 (separate projects) are more desirable than a combined North Saskatchewan Irrigation Project. The following table summarizes the results.

	Unit	Proposal No.			
		#1	#2	#2A	#2B
Irrigation	acres	805,000	805,000	805,000	1,055,000
Firm commercial energy					
produced directly	k.w.h.	-2,000,000	355,000,000	552,000,000	425,000,000
produced indirectly	k.w.h.	0	635,000,000	925,000,000	730,000,000
Total firm energy	k.w.h.	-2,000,000	990,000,000	1,477,000,000	1,155,000,000
Total secondary energy	k.w.h.	15,000,000	160,000,000	155,000,000	155,000,000
Cost of irrigation works	\$	95,000,000	125,000,000	130,000,000	142,500,000
Capitalized net value of power	\$	300,000	31,500,000	47,850,000	37,400,000
Relative capital cost	\$	94,700,000	93,500,000	82,150,000	105,100,000
Relative cost per acre	\$	117.65	116.15	102.05	99.60

Proposal #1 - North Saskatchewan Irrigation Project

This proposal would irrigate some 805,000 acres in both Alberta and Saskatchewan through one distributary system. The necessary water would be obtained from diversions from the North Saskatchewan, Clearwater and Red Deer Rivers, see Figure 1.

Assumptions used were:

Acres irrigated in Alberta	=	350,000 acres
Acres irrigated in Saskatchewan	=	455,000 acres
North Saskatchewan canal capacity	=	3,500 c.f.s.
Clearwater canal capacity	=	5,500 c.f.s.
Ardley-Buffalo Lake canal capacity	=	8,000 c.f.s.
Duty of water in Alberta	=	1.4 acre-feet
Duty of water in Saskatchewan	=	1.5 acre-feet

Reservoirs used for yearly storage

Ardley	=	300,000 acre-feet
Buffalo Lake	=	500,000
Craig & Hamilton Lakes	=	100,000
		<u>900,000 acre-feet</u>

Reservoirs used for seasonal storage

Craig & Hamilton Lakes	=	150,000 acre-feet
Tramping Lake	=	320,000 acre-feet
Plus other small reservoirs		

Minimum flow passing N. Sask. weir	=	1,000 c.f.s.
Minimum flow passing Clearwater weir	=	20 c.f.s.
Minimum flow passing Ardley Dam	=	300 c.f.s.
N. Sask. and Clearwater diversions only for six summer months.		
N. Sask. and Clearwater diversions operated to give, if possible, a maximum monthly average flow of 10,000 c.f.s. at Red Deer.		
Annual pumping requirements in Alberta	=	25,000,000 k.w.h.
Annual pumping requirements in Saskatchewan	=	3,000,000 k.w.h.

Using the above assumptions it was found -

No. of acres irrigated	=	805,000 acres
Firm energy produced	=	26,000,000 k.w.h.
Firm energy req'd for pumping	=	28,000,000 k.w.h.
Therefore salable firm energy	=	-2,000,000 k.w.h.

By provinces, the firm energy picture is -

Alberta	=	+1,000,000 k.w.h.
Saskatchewan	=	-3,000,000 k.w.h.
Secondary energy available in Alberta	=	+15,000,000 k.w.h.

Proposal #2 - Separate Projects (Intermediate Stage)

This proposal, see Figure 2, would develop the same lands as in scheme #1 but uses two separate projects: (a) Red Deer Project - see P.F.R.A. Report of April, 1947, by S. H. Hawkins, and (b) South Saskatchewan River Project - see Summary Report of April, 1951, by P.F.R.A.

The Red Deer Project would obtain water from the Clearwater and Red Deer Rivers to irrigate 350,000 acres in Alberta. It was found that -

Acres irrigated	=	350,000 acres
Firm energy produced	=	48,000,000 k.w.h.
Firm energy req'd for pumping	=	18,000,000 k.w.h.
Salable firm energy	=	30,000,000 k.w.h.
Salable secondary energy	=	10,000,000 k.w.h.

The South Saskatchewan River Project would obtain water from the South Saskatchewan River to irrigate 455,000 acres in Saskatchewan. Assuming 1,700,000 acres irrigated in Alberta it was found that -

Acres irrigated	=	455,000 acres
Firm energy produced	=	365,000,000 k.w.h.
Firm energy req'd for pumping	=	40,000,000 k.w.h.
Salable firm energy	=	325,000,000 k.w.h.
Salable secondary energy	=	100,000,000 k.w.h.

Proposal #2A - Separate Projects (Alternate Final Stage)

This proposal is the same as #2 with the addition of water diverted from the North Saskatchewan River to be used for the production of commercial energy.

At the Red Deer Project this extra energy would be obtained by dropping it 105 feet from Buffalo Lake. The revised results are -

Acres irrigated	=	350,000 acres
Firm energy produced	=	110,000,000 k.w.h.
Firm energy req'd for pumping	=	13,000,000 k.w.h.
Salable firm energy	=	97,000,000 k.w.h.
Salable secondary energy	=	5,000,000 k.w.h.

At the South Saskatchewan River Project this extra water would also be used to create additional energy. The revised results are -

Acres irrigated	=	455,000 acres
Firm energy produced	=	495,000,000 k.w.h.
Firm energy req'd for pumping	=	40,000,000 k.w.h.
Salable firm energy	=	455,000,000 k.w.h.
Salable secondary energy	=	100,000,000 k.w.h.

Proposal #2B - Separate Projects (Alternate Final Stage)

This proposal, see Figure 3, is the same as #2 with the addition of water diverted from the North Saskatchewan River to be used (a) to irrigate an additional 250,000 acres through the Red Deer Project and (b) to produce additional commercial energy.

On the Red Deer Project this extra water could irrigate additional lands to the east of those in proposal #2. The revised results are -

Acres irrigated	=	600,000 acres
Firm energy produced	=	73,000,000 k.w.h.
Firm energy req'd for pumping	=	13,000,000 k.w.h.
Salable firm energy	=	60,000,000 k.w.h.
Salable secondary energy	=	5,000,000 k.w.h.

The revised results on the South Saskatchewan River Project would be -

Acres irrigated	=	455,000 acres
Firm energy produced	=	405,000,000 k.w.h.
Firm energy req'd for pumping	=	40,000,000 k.w.h.
Salable firm energy	=	365,000,000 k.w.h.
Salable secondary energy	=	100,000,000 k.w.h.

Effect of Proposals on Downstream Hydro

In the lower parts of this drainage basin, in Saskatchewan and Manitoba, there are several hydropower sites that would be affected by these proposed developments - see Figures 1, 2 or 3 for locations. The following paragraphs set out the power potentialities of these sites under the various proposals.

On the South Saskatchewan River between Saskatoon and the Forks the river falls about 260 feet. There are two hydrosites, Batoche and Coxby, each with a 75-foot head, in this reach of the river. With the nearly perfect river regulation provided by the South Saskatchewan Reservoir, these two hydroplants become feasible: without this regulation they are definitely uneconomic. The salable firm energy production is -

- for proposal #1 = 0 k.w.h.
 - for proposal #2 = 325,000,000 k.w.h.
 - for proposal #2A = 425,000,000 k.w.h.
 - for proposal #2B = 360,000,000 k.w.h.
- Salable secondary energy for #2, 2A & 2B = 50,000,000 k.w.h.

The Fort a la Corne site, with an average head of 115 feet, will produce salable energy as follows:

- proposal #1 = 525,000,000 k.w.h.
- proposal #2 = 625,000,000 k.w.h.
- proposal #2A = 705,000,000 k.w.h.
- proposal #2B = 665,000,000 k.w.h.

The Nipawin and Squaw sites, with a combined head of 160 feet, will produce 140% of the energy produced at Fort a la Corne, as follows:

- proposal #1 = 730,000,000 k.w.h.
- proposal #2 = 870,000,000 k.w.h.
- proposal #2A = 985,000,000 k.w.h.
- proposal #2B = 930,000,000 k.w.h.

In Manitoba, the proposed Dauphin River Power Project, with a 90-foot head, would produce firm commercial energy at the following annual rates:

- for proposal #1 = 730,000,000 k.w.h.
- for proposal #2 = 800,000,000 k.w.h.
- for proposal #2A = 795,000,000 k.w.h.
- for proposal #2B = 760,000,000 k.w.h.

The following table summarizes the electrical energy picture in relation to the different proposals.

Project	COMMERCIAL ENERGY PRODUCTION IN KILOWATT HOURS YEARLY			
	Proposal No.			
	#1	#2	#2A	#2B
<u>Ardley-Buffalo</u>				
- firm	1,000,000	30,000,000	97,000,000	60,000,000
- secondary	15,000,000	10,000,000	5,000,000	5,000,000
<u>South Saskatchewan</u>				
- firm	3,000,000	325,000,000	455,000,000	365,000,000
- secondary	0	100,000,000	100,000,000	100,000,000
<u>Batoche & Coxby</u>				
- firm	0	325,000,000	425,000,000	360,000,000
- secondary	0	50,000,000	50,000,000	50,000,000
<u>Fort a la Corne</u>	525,000,000	625,000,000	705,000,000	665,000,000
<u>Nipawin & Squaw</u>	730,000,000	870,000,000	985,000,000	930,000,000
<u>Dauphin River</u>	730,000,000	800,000,000	795,000,000	760,000,000

A clearer picture of the effect of these proposals on power potential is given in the following table where proposal #1 is selected as a basis to show, not the resulting gross potential, but the resulting net effects of the different proposals. Note that any other proposal could have been selected as the basis (or datum).

NET ENERGY PRODUCTION IN KILOWATT HOURS YEARLY				
Project	Proposal No.			
	#1	#2	#2A	#2B
<u>Ardley-Buffalo</u>				
- firm	1,000,000	30,000,000	97,000,000	60,000,000
- secondary	15,000,000	10,000,000	5,000,000	5,000,000
<u>South Saskatchewan</u>				
- firm	-3,000,000	325,000,000	455,000,000	365,000,000
- secondary	0	100,000,000	100,000,000	100,000,000
<u>Batoche & Coxby</u>				
- firm	0	325,000,000	425,000,000	360,000,000
- secondary	0	50,000,000	50,000,000	50,000,000
<u>Fort à la Corne</u>	0	100,000,000	180,000,000	140,000,000
<u>Nipawin & Squaw</u>	0	140,000,000	255,000,000	200,000,000
<u>Dauphin River</u>	0	70,000,000	65,000,000	30,000,000

To show the relative capitalized value of the electrical energy resulting from the different proposals the amount of net energy has been multiplied by some mill-rate and capitalized by some percentage. The mill-rate selected has been governed by (a) assumed value of wholesale power and (b) whether or not the hydroplant in question would be built in any event and whether the increase in energy output is 'gravity'. The capitalization percentage was generally assumed to be 8% but was increased in some cases when it was felt the plant would not be constructed for a long time. The following table sets out these assumptions and results.

CAPITALIZED DOLLAR VALUES OF NET ENERGY PRODUCTION						
Project	Mill-rate	Capitalize	Proposal No.			
			#1	#2	#2A	#2B
<u>Ardley-Buffalo</u>						
- firm	2.5	8%	30,000	1,000,000	3,000,000	1,900,000
- secondary	2.0	8	370,000	250,000	100,000	150,000
<u>South Sask.</u>						
- firm	3.0	8	-100,000	12,000,000	17,000,000	13,500,000
- secondary	2.0	8	0	2,500,000	2,500,000	2,500,000
<u>Batoche & Corby</u>						
- firm	1.0	12	0	2,700,000	3,500,000	2,900,000
- secondary	1.0	12	0	400,000	400,000	400,000
<u>Fort a la Corno</u>	5.0	8	0	6,250,000	11,250,000	8,750,000
<u>Nipawin & Squaw</u>	4.0	12	0	4,700,000	8,500,000	6,600,000
<u>Dauphin River</u>	3.0	12	0	1,700,000	1,600,000	750,000
Total Firm			-70,000	28,350,000	44,850,000	34,400,000
Total Secondary			370,000	3,150,000	3,000,000	3,000,000
TOTAL			\$300,000	31,500,000	47,850,000	37,400,000

Conclusion

Estimated capital costs of the different proposals, excluding the power features^a, are as follows:

Proposal #1	-	\$ 95,000,000 ^b
Proposal #2	-	125,000,000 ^b
Proposal #2A	-	130,000,000 ^c
Proposal #2B	-	142,500,000 ^d

Having then the cost of constructing the different proposals and also the capitalized value of the net energy production resulting therefrom, it is possible to now determine their relative costs

Item	Proposal No.			
	#1	#2	#2A	#2B
Acres irrigated	805,000	805,000	805,000	1,055,000
Cost of proposal	\$95,000,000	125,000,000	130,000,000	142,500,000
Capitalized energy	300,000	31,500,000	47,850,000	37,400,000
<u>Relative cost of proposal</u>	\$94,700,000	93,500,000	82,150,000	105,100,000
<u>Relative cost per acre</u>	\$117.65	\$116.15	\$102.05	\$ 99.60

It should be noted that the 'relative' costs set out above are not actual costs but represent the net costs in relation to proposal #1 (i.e. proposal #1 used as datum).

According to the assumptions used herein, it appears, therefore, that on the basis of costs -

1. There is little to choose between a combined project (#1) and the intermediate stage of development of separate projects (#2), but

2. With the additional water available from the North Saskatchewan River (#2A or #2B), it would definitely be more desirable to build separate projects than a combined project.

^a - The cost of the power features of each proposal (penstocks and power house only) were allowed for when assuming the mill-rate value of the energy.

^b - Assuming Mr. B. Russell's estimate of \$92,000,000 is correct, plus the cost of the necessary increased diversions from the North Saskatchewan River and the necessary pumping plants required for the lands near Saskatoon.

^c - Allowing \$30,000,000 for the Red Door Project and \$95,000,000 for the South Saskatchewan River Project (without power features).

^c - Allowing \$5,000,000 for cost of diverting the North Saskatchewan River.

^d - Allowing \$50.00 per acre as the cost of increasing the Red Door Project by 250,000 acres.

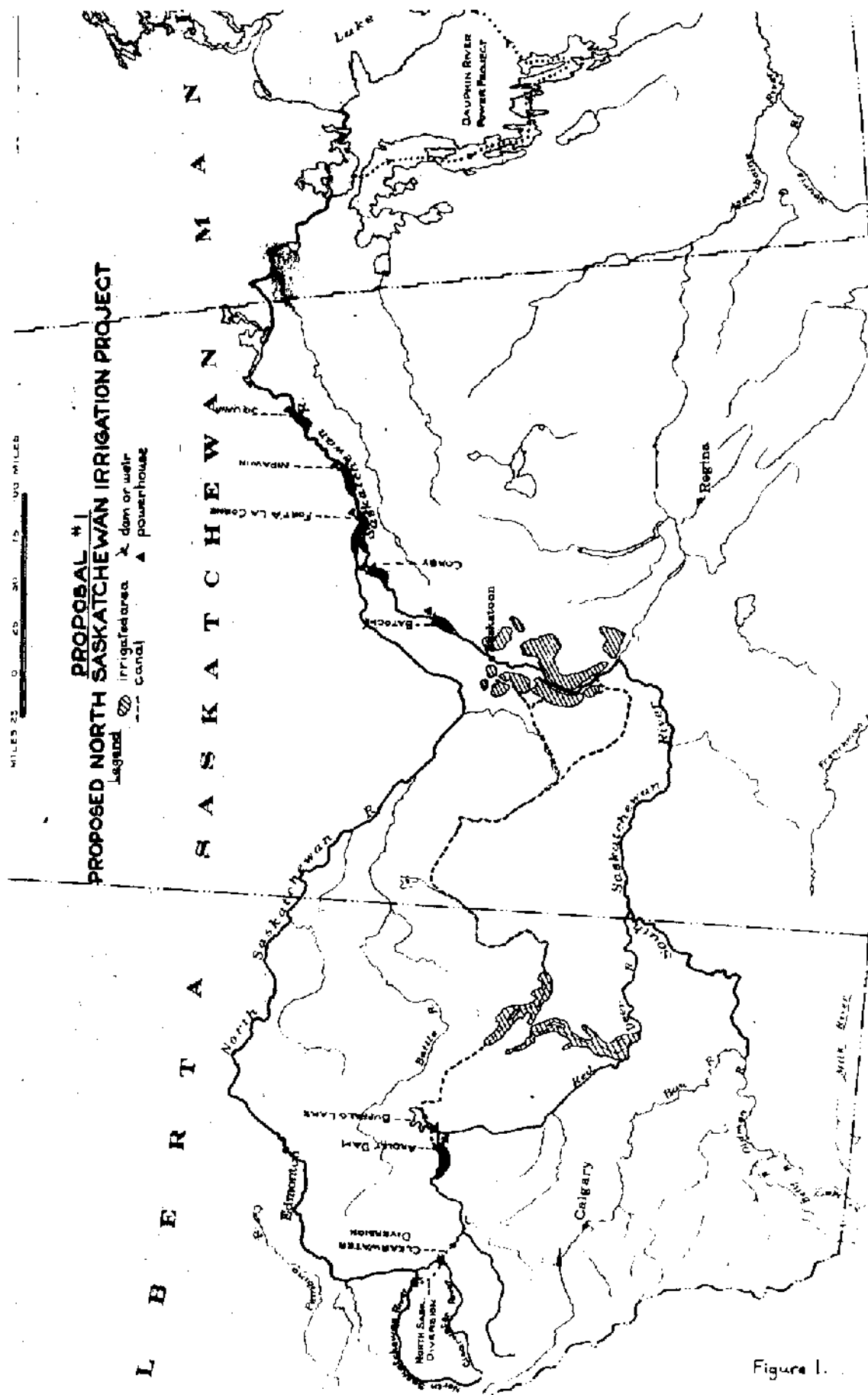


Figure 1.

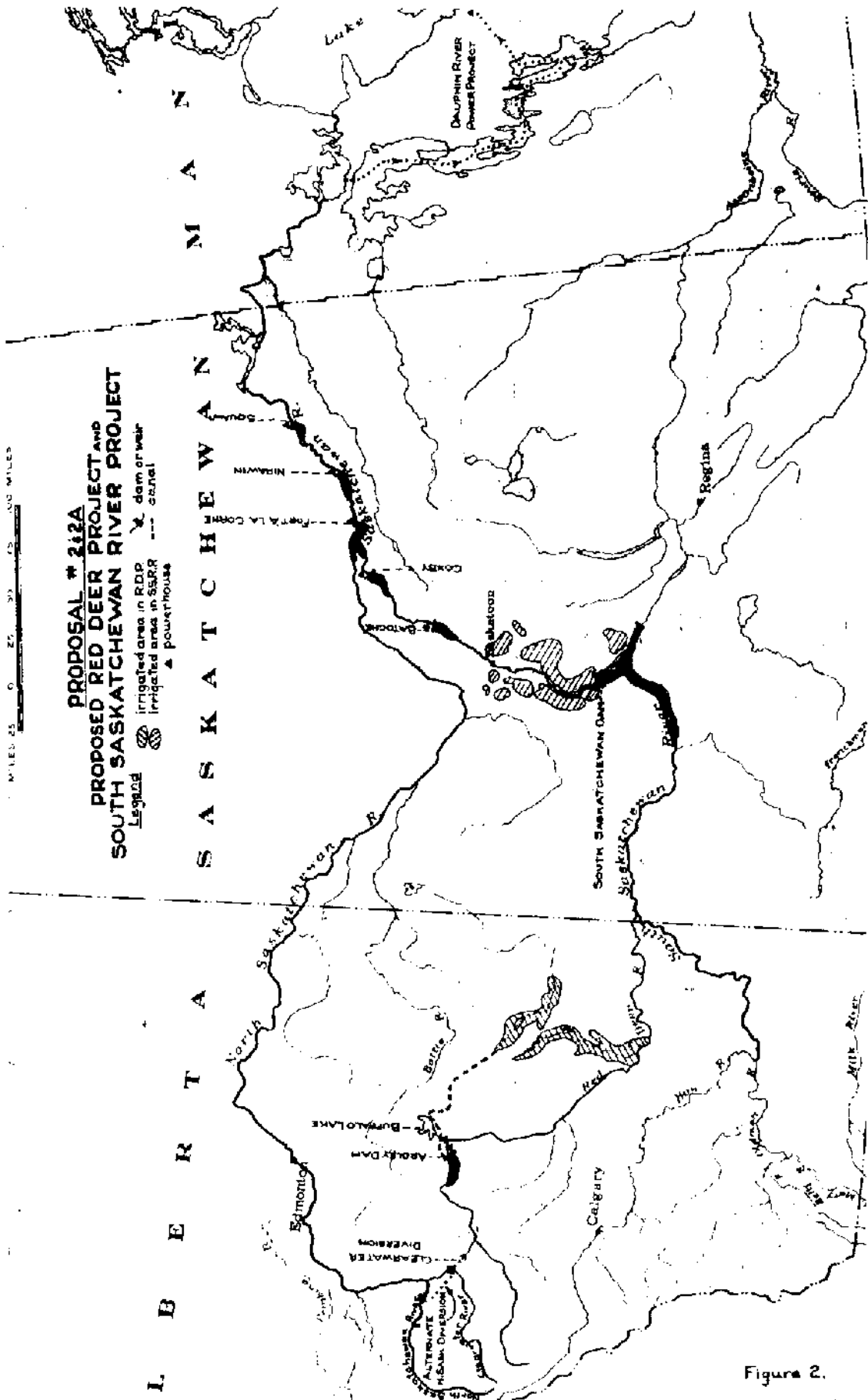
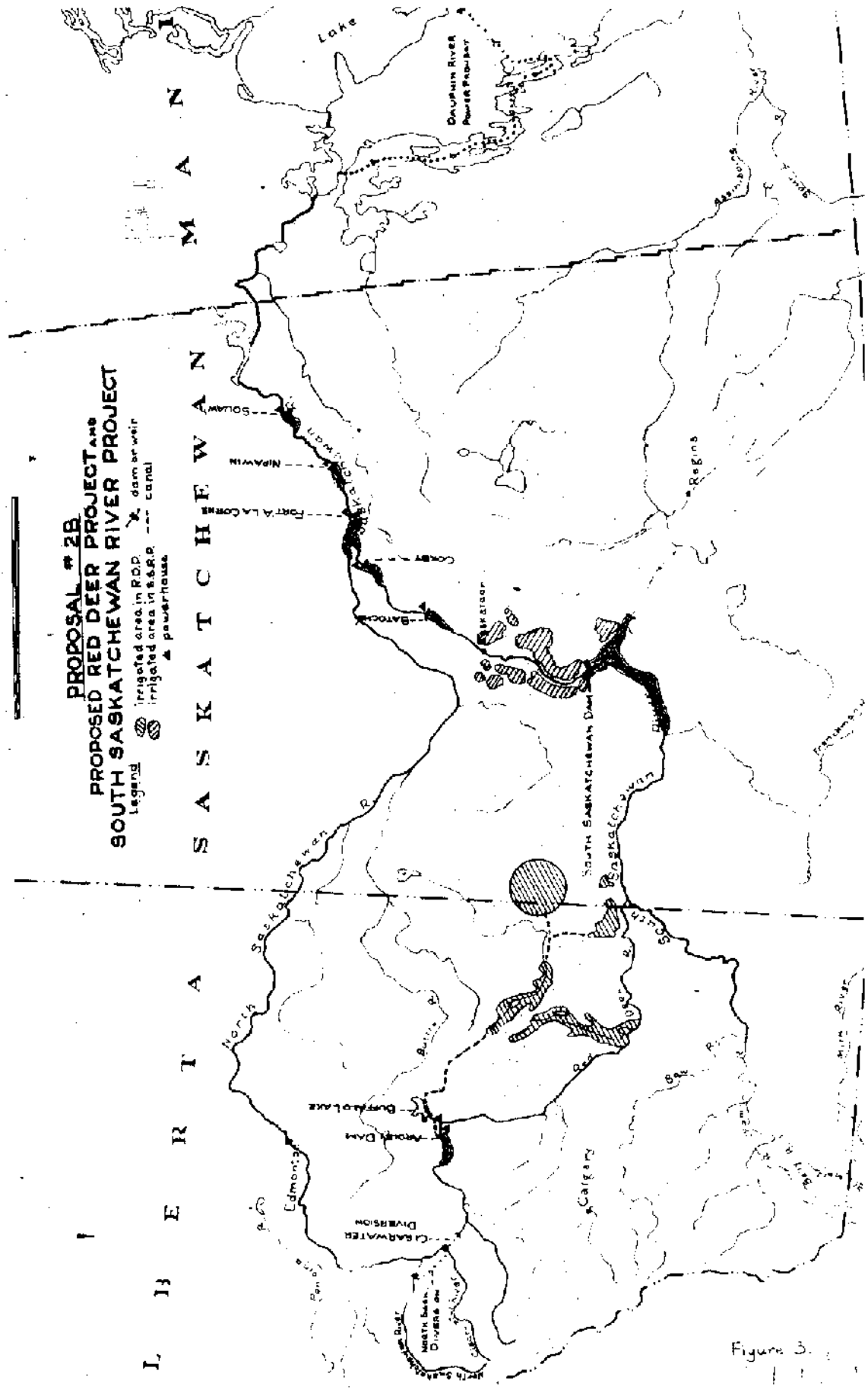


Figure 2.



PROPOSAL # 2B
PROPOSED RED DEER PROJECT AND
SOUTH SASKATCHEWAN RIVER PROJECT

Legend
 Irrigated area in R.D.P. (shaded with diagonal lines)
 Irrigated area in S.R.P. (shaded with cross-hatch)
 dam or weir (solid line with cross)
 canal (dashed line)
 powerhouse (small square)

Figure 3.