BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

British Columbia Hydro and Power Authority, System Engineering Division - Hat Creek Detailed Environmental Studies - Land Resources Bridging Document - December 1979

ENVIRONMENTAL IMPACT STATEMENT REFERENCE NUMBER: 35

ERRATA

HAT CREEK DETAILED ENVIRONMENTAL STUDIES
LAND RESOURCES
BRIDGING DOCUMENT

Page 4-2, Table 4-1 to Table 4-9:

Beginning on page 4-2, all tables 4-1 through 4-9 should show footnote 1 at the end of the title for each table

Page 4-5, Paragraph 3, line 1:

Change "affect" to "effect"

Page 4-27, Table 4-19, footnote 3:

Delete footnote 3.

Page 4-28, Paragraph 1, line 3:

Change "maps" to "map"

Page 4-28, Paragraph 1, line 3:

Change sentence to read "However, the determination of impacts in the bridging document and the credibility of any statements made about the potential impacts necessitated the completion of this map."

Page 5-4, Paragraph 2, line 3:

Change "new ERT Acid Rain[15] report" to "revised Acid Rain[15] report."

Page 6-2, Paragraph 1, lines 2 and 3:

Change "(tables 5-3 and 5-7)[9] and qualitative soil ratings (table 5-2)[9]" to "(tables 5-3 and 5-7)[8] and qualitative soil rating (table 5-2)[8]".

Page 6-8, Paragraph 1, line 1:

Change "10 percent" to "14 percent".

Page 6-24, Table 6-16, footnote 5:

Change "a 2-month spring season" to "a 3-month summer season".

.../2

Page C-5 — Table C-1 under Impact (Loss of Water) change "242" to "250" for both gauging stations.

Under Net Available Downstream for the "With the Project" case change "814" to "806" and "1137" to "1129"

Page C-6 — Paragraph 2 line 3:

"average 250 ha.m."

Paragraph 4, line 6:

Change "(35 h.m)" to "(35 ha.m)".

Paragraph 5 line 1:

Change "814 ha.m" to "806 ha.m".

Paragraph 5 line 2:

Change "1137 ha.m" to "1129 ha.m".

Page C-7, — Paragraph 1, line 3:

Change "(may - September)" to "(May - September)".

HAT CREEK DETAILED ENVIRONMENTAL STUDIES

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APPENDICES

SECTION 1.0 - INTRODUCTION

The production of this Land Resources Bridging Document was developed in response to the evolution of the Hat Creek project design. The alteration of the base engineering design on which original detailed environmental studies were based resulted in changes to impacts on the Land Resources. Consequently, a reevaluation of the project impacts was undertaken. The bridging document is designed to bridge the gap between the original base engineering design and the selected project plan.

SECTION 2.0 - METHODOLOGY

In order to incorporate the project design changes into the detailed environmental assessments, a recalculation of the project areas was necessary. This established direct alienation impacts for physical habitat and range vegetation, wildlife, forestry and agriculture. The alienation figures for each project facility were used directly for the physical habitat and range vegetation and wildlife sections. However, forestry and agriculture required a further assessment in order to bring the economic assessments up to date. The procedure to do this was identical to that outlined in the methodology sections of the Forestry[1] and Agriculture[2] reports.

It should be emphasized that the area calculations in Table 3-1 and Table 4-1 to Table 4-9 are approximate. The method of calculation using a planimeter and dot grids naturally is subject to inaccuracies due to map scale differences, boundary thickness and operator bias. Rounding of the numbers also results in small errors. Consequently, it can not be expected that areas for each facility will be identical, although the magnitude of the errors is small.

The evaluations of air emission and trace element impacts were done by reviewing the latest information on these topics and determining if the projected impacts were going to be greater or less than originally assessed. If they were less or equivalent to the impacts originally stated, then no further assessment was undertaken. However, in the event of a greater anticipated impact, a complete review and reevaluation took place following a similar methodology as used in the original detailed environmental studies.

SECTION 3.0 - NEW PROJECT DESCRIPTION

The selected project layout and description is given in Fig. 3.3 of the Hat Creek Project Environmental Impact Statement.[3] The areas of the various project facilities described there are shown in Table 3-1. These areas were used in the assessment of direct alienation impacts. The main differences between the present project design and the original "base" engineering layout which has been described in other documents[4,5,6,7] are as follows:

1. Wet ash disposal changed to dry ash disposal.

2. 366 m stack/MCS changed to 244 m stack/MCS.

3. Two mechanical draft cooling towers changed to two natural draft cooling towers.

4. Makeup water reservoir moved to Medicine Creek valley.

5. Deletion of Site 2 storage reservoir.

In addition to the above major changes, many project facilities have been added and subtracted to meet the needs of the engineering and environmental concerns. These cannot be discussed in detail because of the number of changes. However, the summary table (Table 3-2) expresses the changes for the major facilities, and plant, mine and offsites.

The selection of a 244 m stack with MCS was based on a benefit/cost analysis.[20] The benefit/cost analysis concluded that the 244 m/MCS was the preferred option in terms of comparitive costs while the differences in environmental impacts both qualitative and quantitative, were insignificant.

TABLE 3-1

AREA SUMMARY FOR PROJECT FACILITIES. July, 1979

Facility: Plant

	Approximate Area in hectares (rounded)	
Fenced Power Plant Site	99.2	(99)
Make-up Water Reservoir and Dams	94.1	(94)
60 kV Transmission Lines from Mine to Plant Substation	6.9	(7)
Power Plant Construction Camp, Housing and Parking	11.3	(11)
Power Plant Construction Camp Water Supply Pipeline	1.5	(2)
Common Corridor *	7.9	(8)
Ash Transport Conveyor	4.1	(4)
60 kV Lines (Ash to Plant)	7.8	(8)
Plant Site Access and Conveyor Service Road	6.2	(6)
Water Supply Pipe	6.9	(7)
Ash Run-off Pond Water Pipeline	0.6	(1)
Total	246.5	(247)

* Ash Transport Conveyor
60 kV Lines (Ash to Plant)
Plant Site Access and Conveyor Service Road
Water Supply Pipe

FACILITY: OFF-SITE

	Approximate Area in hectares (rounded)	
Main Access Road	117.0	(117)
Power Plant Site Access Road	9.7	(10)
60 kV Transmission Line from Rattlesnake Substation to Booster Station II	9.0	(9)
60 kV Transmission Line from Rattlesnake Substation to Booster Station I	21.2	(21)
Rattlesnake Substation	3.0	(3)
Pit Rim Reservoir and Dam	10.5	(11)
Pipeline, Pit Rim Reservoir to Canal, and Pump Station	0.4	-
Pipeline from Canal to Make-up Reservoir	12.2	(12)
Potential Nursery	10.2	(10)
Environmental Services Lab	0.4	-
Site Run-off Holding Pond	2.2	(2)
Relocated Hat Creek Road	7.0	(7)
Meterological Tower	1.5	(2)
Pump House/Conveyor Road	3.6	(4)
Overflow Ditch to Reservoir	0.6	(1)
Site Drainage Ditch	1.9	(2)
Finney Lake Diversion Canal	8.4	(8)
Make-up Water Pipeline to Thompson River	35.2	(35)
Hat Creek Diversion Canal	41.1	(41)
Headworks Dam	6.1	(6)
Airstrip (A)	45.0	(45)
Offloading Area	3.0	(3)
Airstrip Access Road	6.4	(6)
60 kV Substations	0.7	(1)
Total	356.4	(356)

FACILITY: MINE

	Area (in hectares)	
Mine Construction Camp Housing and Parking	4.8	(5)
Mine Construction Access	0.5	(1)
Mine Construction Camp Water Supply and Pipeline	0.2	-
Open Pit #1	584.2	(585)
Medicine Creek Mine Waste and Ash Disposal Embankments	426.9	(427)
Houth Meadow Mine Waste Embankment	601.3	(601)
Leachate Storage and Sedimentation Lagoons	22.8	(23)
Coal Blending Area	41.5	(42)
Low Grade Coal Stocking Area	40.2	(40)
Maintenance Buildings	25.2	(25)
Minewaste Conveyors	22.3	(22)
Coal Conveyor	7.3	(7)
60 kV Lines (Waste and Mine)	42.1	(42)
Mine Road	37.3	(37)
Lower S.W. Diversion Drains	3.4	(3)
S.E. Diversion Drains	1.1	(1)
Upper S.W. Diversion Drain	2.2	(2)
North Perimeter Diversion Drain	2.3	(2)
West Perimeter Diversion Drain	7.1	(7)
South Run-off Canal	13.7	(14)
North Run-off Canal	7.8	(8)
Minor Diversion Drains	4.7	(5)
North Slide Diversion Drain	2.9	(3)
South Slide Diversion Drain	1.2	(1)
Total	1903.0	(1903)

Total Facility: 2505.9 hectares (2506 ha)

TABLE 3-2

SUMMARY TABLE OF PROJECT CHANGES
(Hectares)

Selected Project Facility	Original Base Engineering Scheme	Selected Project Scheme	Difference	Percent Reduction
Open Pit No. 1	767	584	-183	24
Houth Meadows waste dump	615	601	-14	2
Medicine Creek waste dump	487	427	-60	12
Makeup water reservoir and dams	67	94	+27	increase (40%)
Fenced powerplant site	92	99	+7	increase (8%)
Mine waste conveyors	31	22	-9	29
Coal blending area	30	42	+12	increase (40%)
Low grade coal stacking area	124	40	+84	68
All plant-related facilities	842	247	-595	71
All mine-related facilities	2336	1903	-433	19
All offsite-related facilities	476	356	-120	25
TOTAL	3654	2506	-1148	31

The recommendation to incorporate two natural draft cooling towers and the dry ash disposal option into the selected project design again was based on cost and environmental considerations. In both cases the environmental impacts were less for these options than the original base engineering design.[1,2,8,9]

SECTION 4.0 - EFFECT OF THE NEW PROJECT DESIGN ON THE LAND RESOURCES

The effects of the various project design changes were analysed by comparing the selected project design to the original base engineering configuration. This was completed for both direct alienation and indirect effects such as air emissions.

4.1 PHYSICAL HABITAT AND RANGE VEGETATION

The assessment of physical habitat and range vegetation used a combined qualitative-quantitative analysis to predict the effects of the selected project design. Qualitative information was extracted from Tables 5-2 and 5-11 of the Physical Habitat and Range Vegetation Report,[8] while new project alienation figures were generated as stated in the Methodology Section above.

(a) Physical Habitat

(i) Direct Alienation - Construction and Operation

Tables 4-1, 4-2 and 4-3 present the soil type areas alienated for the plant, mine and offsites respectively. It should be noted that in most cases the respective area alienation is reduced for the soil types compared to the original base engineering scheme. Certain increases occur where project facilities have been moved or added. However, the overall effect is still considerably lower than originally estimated based on quantitative area data.

Previous discussions concerning effects of project development on climate, landforms and geology are still considered valid.[8] No further discussion on these topics will be introduced in this bridging document.

TABLE 4-1

SOIL TYPES PREDICTED TO BE ALIENATED BY POWER PLANT DEVELOPMENT

Soil unit	Soil description	Fenced power plant	Make-up water reservoir and dams	60 kV transmission lines from mine to plant substation	Power plant construction camp, housing and parking	Power plant construction camp water supply pipeline	Common* corridor	Ash transport conveyor	60 kV lines (ash to plant)	Plant site access and conveyor service road	Water supply pipe	Ash run-off pond water pipeline	TOTAL (hectares)	SENSITIVITY TO EROSION
6A	Degraded Eutric Brunisol/Orthic Dark Brown Chernozem					(0.57)							1	Moderate
16	Carbonated Black Chernozem		3										3	Moderate
18	Degraded Eutric Brunisol			2		<1 (0.22)							2	Moderate
19	Degraded Eutric Brunisol/Orthic Dark Brown Chernozem			<1 (0.29)		(0.50)							1	High
31	Degraded Eutric Brunisol/Rego Brown Chernozem			<1 (0.05)	3								3	Moderate
34	Lithic Eutric Brunisol			1		<1 (0.10)							1	Moderate
35	Degraded brown Brunisol							1	3	4	4	<1 (0.28)	12	Moderate
36	Rego Dark Gray Chernozem			1	<1 (0.44)	<1 (0.40)							2	Moderate
37	Orthic Gray Luvisol/ Degraded Eutric Brunisol			1		<1 (0.25)							1	Moderate
38	Orthic Gray Luvisol		31	1			1	2	2	2	2	<1 (0.31)	41	Moderate
41	Orthic Gray Luvisol	8											8	Moderate
47	Gleyed Orthic Gray Luvisol		1										1	Low
51	Calcareous Black Chernozem	6	9	<1 (0.48)			5	<1 (0.33)	2			<1 (0.06)	23	Moderate
52	Orthic Gray Luvisol/ Gleyed Gray Luvisol		<1 (0.29)										<1	Moderate
53	Calcareous Black Chernozem		14										14	Moderate
54	Orthic Gray Luvisol/Lithic Gray Luvisol	24					<1 (0.24)						24	Moderate
55	Gleyed Carbonated Black Chernozem		10										10	High
56	Orthic Dark Brown Chernozem/Calcareous Black Chernozem		24										24	Moderate
57	Orthic Dark Brown Brunisol/ Degraded Eutric Brunisol		2						1	1	1		5	High
58	Lithic Dark Gray Chernozem	60		1	8	<1 (0.22)		1			1		71	Moderate
60	Gleyed Orthic Luvisol	3		1		<1 (0.08)	1						5	Moderate
L	Lake	1											1	-
RO	Rock Outcropping Rego Brown						1						1	Low
	TOTAL	100	94	9	11	2	8	4	8	7	8	1		

* Common Corridor: Ash Transport and Conveyor
60 kV Lines Ash to Plant
Water Supply Pipe
Plant Site Access and Conveyor Service Road

Total area alienated by plant development - 251 (ha)

† Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

TABLE 4-2

SOIL TYPES PREDICTED TO BE ALIENATED
BY MINE DEVELOPMENT

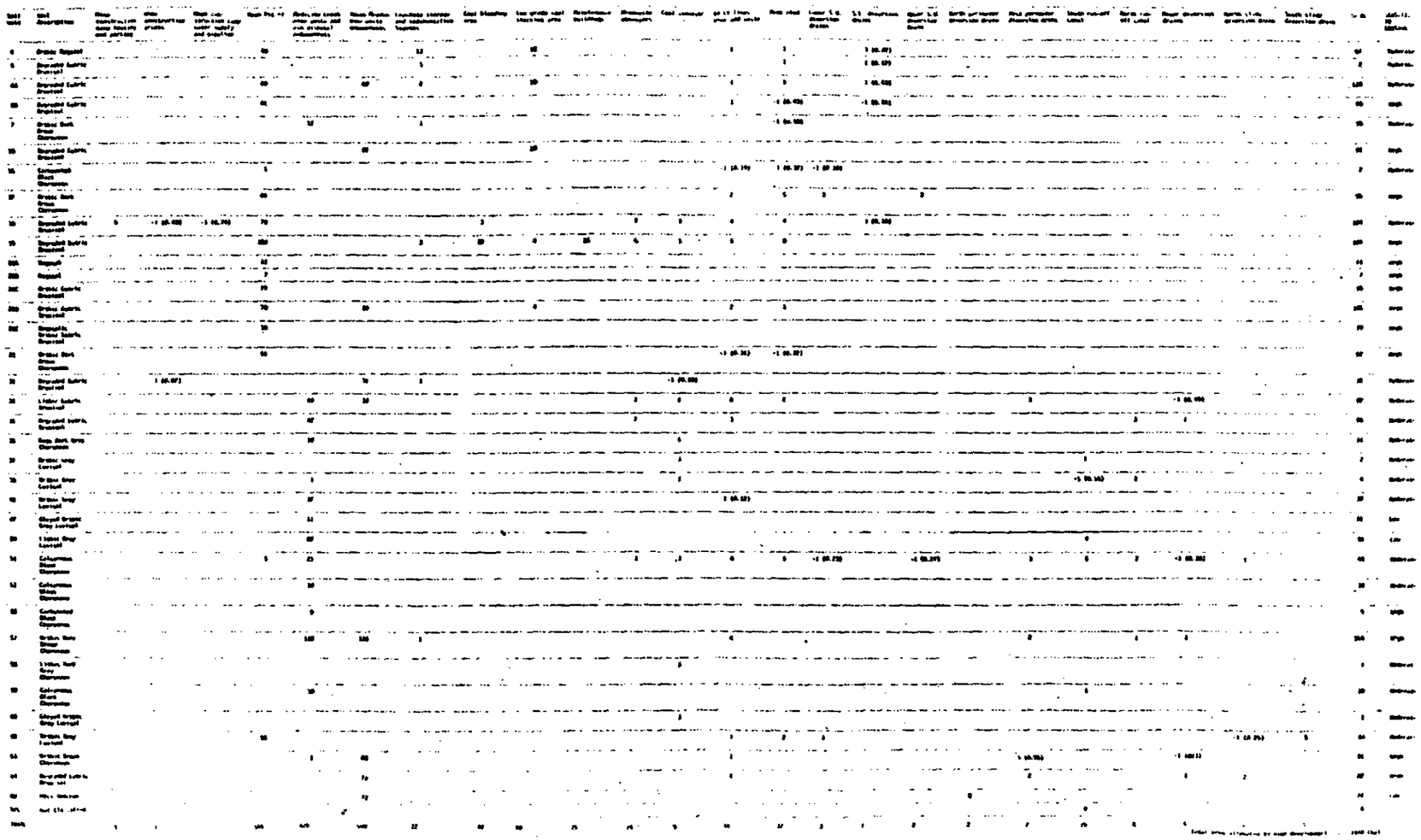
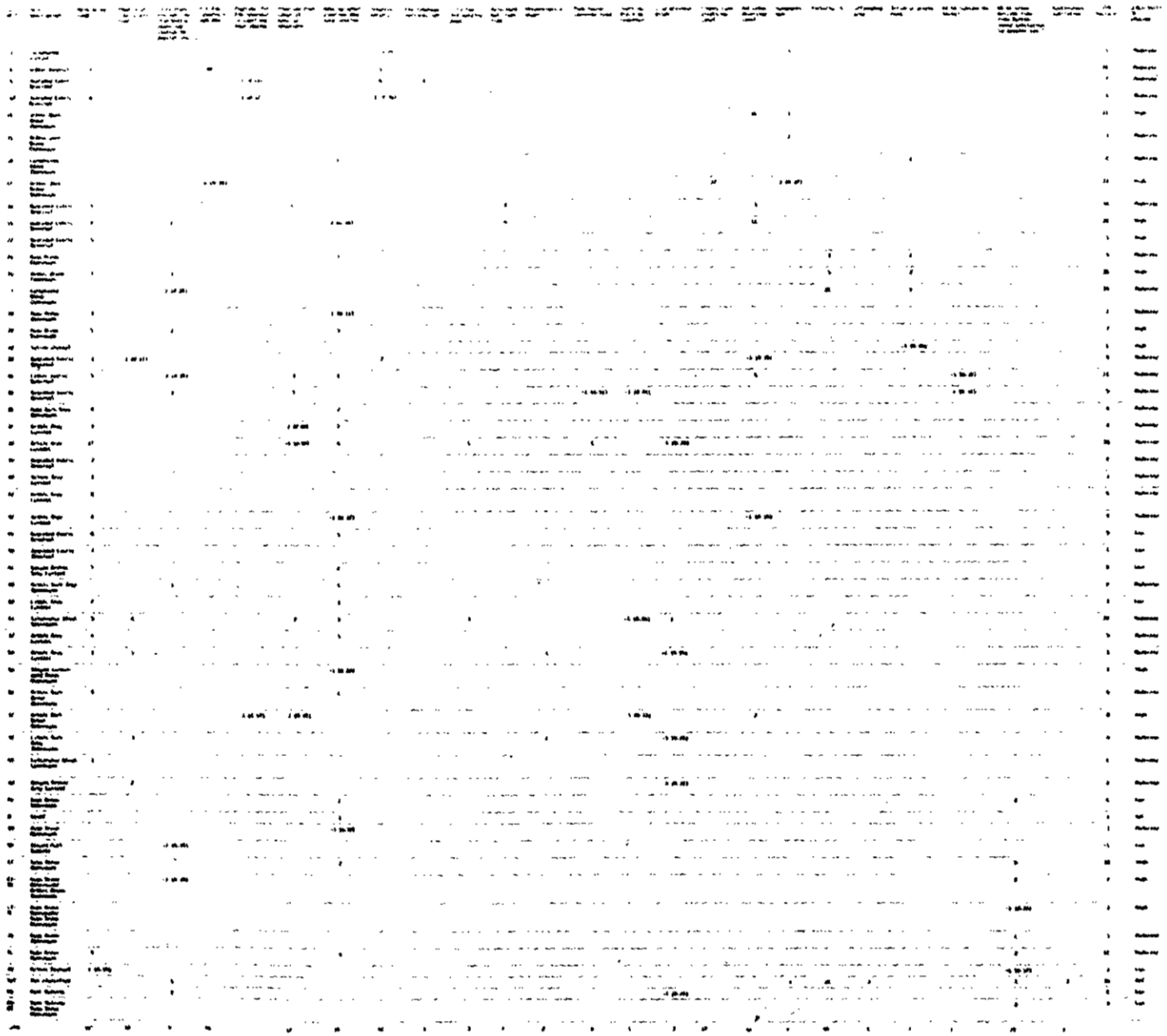


TABLE 4-3

SOIL TYPES PREDICTED TO BE ALIENATED
BY OFFSITE DEVELOPMENT



4.1 PHYSICAL HABITAT AND RANGE VEGETATION - (Cont'd)

(ii) Waste Disposal

The revised plans[3] for the ash disposal indicate the dry ash scheme in which both conditions fly ash and dump bottom ash will be disposed of in mid-Medicine Creek valley west of the new water supply reservoir.[3]

Mine waste disposal facilities do not alter significantly to affect environmental concerns. Drainage systems have been refined and increased. Leachate storage is planned at both waste dumps (Houth Meadows and Medicine Creek). This reflects the adoption of a zero discharge system for low quality drainages by the mine operation.

No increase in the affect on the soil resource is anticipated from mine, plant or offsite-generated wastes to that originally documented.[8]

(iii) Decommissioning

The impacts resulting from this phase of development are still expected to be minimal. No major changes to the decommissioning plans have taken place.

(b) Range Vegetation

(i) Direct Alienation - Construction and Operation

Tables 4-4, 4-5 and 4-6 show the vegetation associations predicted to be alienated by the plant, mine and offsite facilities, respectively. As shown in Table 3-2 and illustrated for vegetation, the area of vegetation alienated has been reduced by 70 percent, 19 percent and 26 percent for the plant, mine and

TABLE 4-4

VEGETATION ASSOCIATIONS PREDICTED TO BE ALIENATED BY POWER PLANT DEVELOPMENT

Facility / Vegetation association	Fenced power plant site	Make-up water reservoir and dams	60 kV transmission lines from mine to plant substn.	Power plant construction camp housing and parking	Power plant construction camp water supply pipeline	Common * corridor	Ash transport conveyor	60 kV lines ash to plant	Ash run-off pond water pipeline	Water supply pipe	Plant site access and conveyor service road	TOTAL (hectares)	PERCENT (%) OF LOCAL AREA AFFECTED	SENSITIVITY TO DISTURBANCE
Douglas-fir - pinegrass association	87	11	1	8	<1 (0.22)	1				1	1 (0.16)	111	1	Low
Douglas-fir - bunchgrass - pinegrass association	5		3		1		3	5	1	6	5	29	1	Low
Kentucky bluegrass association	7	78	1	3	<1 (0.48)	7	1	3	<1 (013)	<1 (0.29)	1	102	2	Low
Willow - sedge bog association		5										5	1	High
TOTAL	99	94	7	11	2	8	4	8	1	7	6			

* Common Corridor: Ash Transport Conveyor
60 kV lines Ash to Plant
Water Supply Pipe
Plant Site Access and Conveyor Service Road

Total area alienated by plant development - 247 (ha)

1 Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

TABLE 4-5

VEGETATION ASSOCIATIONS PREDICTED TO BE ALIENATED BY MINE DEVELOPMENT

Vegetation association / Facility	Mine construction camp housing and parking	Mine construction access	Mine construction camp water supply and pipeline	Open Pit(s)	Medicine Creek mine and waste disposal embankments	Mouth Meadow mine waste embankments	Leachate storage and sedimentation lagoons	Coal blending area	Low grade coal stocking area	Maintenance buildings	Mine/waste conveyors	Coal conveyors	AC kV / mps (waste and mine)	Mine road	Lower S.W. diversion drains	S.E. diversion drains	Upper S.W. diversion drain	North perimeter diversion drain	West perimeter diversion drain	South run-off canal	North run-off canal	Minor diversion drains	North slope diversion drain	South slope diversion drain	TOTAL (hectares)	PERCENT (%) OF LOCAL AREA AFFECTED	SENSITIVITY TO DISTURBANCE
Douglas-fir - pinegrass association				26	71	372					3	7	14	7	1		1	<1 (0.10)	7	10		1	3	1	517	1	Low
Douglas-fir - bunchgrass association				50		14	3		9				3	6	1										82	2	Moderate
Douglas-fir - spirea - serviceberry association/ Douglas-fir - bunchgrass - pinegrass complex						90												2							92	6	High
Douglas-fir - bunchgrass - pinegrass association	5	1	<1 (0.26)	110	214		3	30	13	25	16	3	16	13							5	2			466	7	Moderate
Riparian association				9																					10	1	High
Rock					8	2	2						<1 (0.17)	<1 (0.18)											12	2	Low
Cultivated fields							1							1		<1 (0.24)			<1 (0.09)						2	<1	High
Kentucky bluegrass association					133	116	6		17		6	2	2						1	3	3	<1 (0.37)			291	6	Low
Bunchgrass - Kentucky bluegrass association				16	1		5	3					2	4	<1 (0.24)	<1 (0.46)	<1 (0.18)								32	1	Low
Bunchgrass - Kentucky bluegrass/saline depression complex				16											<1 (0.13)		1								17	1	Moderate
Sagebrush - bluebunch wheatgrass association				358		8			5				5	7	1	1									385	57	High
Kentucky bluegrass association/Riparian complex							2																		2	<1	Moderate
TOTAL	5	1	-	585	427	602	24	42	48	26	23	7	42	39	3	2	2	2	8	13	8	3	3	1			

Total area alienated by mine development - 1907 (ha)

! Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

TABLE 4-6

VEGETATION ASSOCIATIONS PREDICTED TO BE ALIENATED BY OFFSITE DEVELOPMENT

Vegetation Association \ Facility	Access Road	Power plant site access road	60 kV transmission line from Rattlesnake substation to Booster Sta. II	Pit Rim reservoir and dam	Pipeline, Pit Rim reservoir to canal and pump station	Pipeline from canal to make-up reservoir	Make-up water pipeline and pump station	Potential Nursery	Environmental services lab	Site run-off holding pond	Relocated Hot Creek road	Meteorological center	Pump house/ conveyor road	Overflow ditch to reservoir	Site drainage ditch	Finney Lake diversion canal	Hot Creek diversion canal	Headworks dam	Airstrip 'A'	Offloading area	Airstrip access road	60 kV substations (misc)	60 kV transmission line from Rattlesnake substation to Booster Sta. I	Rattlesnake substation	TOTAL (hectares)	PERCENT (%) OF LOCAL AREA AFFECTED	SENSITIVITY TO DISTURBANCE
Douglas-fir - pinegrass association	40	5	2			1	17					2	4		1							<1 (0.17)			72	<1	Low
Douglas-fir - bunchgrass association	3															<1 (0.36)									3	<1	Moderate
Douglas-fir - bunchgrass - pinegrass association	31					7				1	7			<1 (0.33)	<1 (0.06)		21					<1 (0.29)			68	<1	Moderate
Engelmann spruce - grouseberry association	10																								10	<1	Low
Riparian association				1														3							4	<1	High
Cultivated fields	3				<1 (0.12)		8	9	<1 (0.37)														<1 (0.16)		21	<1	High
Kentucky bluegrass association	15	4				4	4			3				<1 (0.30)	1										29	1	Low
Big sage - bunchgrass association	15		7				6												42	3	6		21	3	103	<1	Low
Bunchgrass - Kentucky bluegrass association				10	<1 (0.29)			1									19	1							31	1	Low
Bunchgrass - Kentucky bluegrass/ saline depression complex																7		2							9	<1	Moderate
Sagebrush - blue-bunch - wheatgrass association																1	1								2	<1	High
Saline depression association																			3						3	10	Moderate
TOTAL	117	9	9	11	-	12	35	10	-	2	7	2	4	1	2	8	41	5	45	3	6	1	21	3			

Total area alienated by offsite development - 355 (ha)

1 Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

offsite facilities, respectively. For the plant (Table 4-4) all vegetation associations were alienated to a lesser degree when compared to the original base engineering design.[8] The offsite facilities (Table 4-6) followed a similar trend except for the Douglas-fir - pinegrass and bunchgrass - Kentucky bluegrass associations which increased by 8 and 21 ha, respectively. The alienation to the vegetation associations by the mine facilities was reduced for all except the Douglas-fir - bunchgrass - pinegrass and bunchgrass - Kentucky bluegrass associations which increased in area alienated by 34 and 19 ha, respectively, based on the original base engineering design.[8]

In all cases the increases were confined to vegetation associations that exhibited a low to moderate qualitative sensitivity rating.[8]

(ii) Waste Disposal

With the adoption of the zero discharge philosophy for all low quality waters (leachates, seepage, mine water and coal pile runoff), many of the previously suggested impacts are unlikely to occur.[8] In addition, any impact from seepage of low quality leachates such as those from the ash disposal area[10] would probably be reduced by several of the following factors:

1. High buffering capacity of soil materials,

2. Dilution of leachates by groundwaters,

3. Deep percolation of leachates away from the rooting zone.

4.1 PHYSICAL HABITAT AND RANGE VEGETATION - (Cont'd)

Consequently, it is very unlikely that any impacts can be attributed to leachates from the waste dumps, ash disposal or leachate storage lagoons.

The reclamation of the mine waste dumps and ash disposal dump may still be influenced by high trace element levels. Ongoing studies[11,12,13] will determine if any problems with high trace element levels exist. Covering the ash materials may be desirable to avoid potential growth problems caused by trace elements in the ash. The effects of trace elements on plant growth is discussed by Acres, Section 7.5, Land Reclamation.[14]

(iii) Indirect Changes

No changes are expected to occur as a result of the new project description. The indirect changes originally discussed[8] are still valid.

(iv) Decommissioning

Previous discussions (Physical Habitat and Range Vegetation Report)[8] concerning decommissioning of the mine, plant and offsite facilities are still valid.

4.2 WILDLIFE

(a) Direct Alienation - Construction and Operation

Tables 4-7, 4-8 and 4-9 show the predicted area alienated of each wildlife habitat for the plant, mine and offsite facilities. A comparison of the selected project design and the original base engineering design yielded the following results.

TABLE 4-7

WILDLIFE HABITATS PREDICTED TO BE
ALIENATED BY POWER PLANT FACILITIES

Wildlife habitat \ Facility	Fenced power plant site	Make-up water reservoir and dams	60 kV transmission lines from mine to plant substation	Power plant construction camp housing and parking	Power plant construction water supply pipeline	Common * corridor	Ash transport conveyor	60 kV lines ash to plant	Water supply pipe	Plant site access and conveyor service road	Ash run-off water pipeline	TOTAL (hectares)	PERCENT (%) OF LOCAL AREA AFFECTED
Aspen or mixed aspen - conifer habitat	64			5		1						70	3
Douglas-fir/ pinegrass habitat	24	10	4	4	<1 (0.43)		2	3	3	3	<1 (0.38)	54	<1
Ponderosa pine - Douglas-fir/ bunchgrass habitat			2		1		1	2	2	2	<1 (0.19)	11	<1
Mid elevation grassland	10	80	1	2	<1 (0.44)	7	1	3	1	1	<1 (0.07)	107	2
Brush habitat	2											2	<1
Bog habitat		3										3	<1
TOTAL	100	93	7	11	2	8	4	8	6	6	1		

* Common corridor: Ash Transport Conveyor
60 kV lines Ash to Plant
Water Supply Pipe
Plant Site Access and Conveyor Service Road

Total area alienated by plant development - 249 (ha)

1 Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation Maximum expected error in final total is ± 10 ha.

TABLE 4-8

WILDLIFE HABITATS PREDICTED TO BE ALIENATED BY MINE DEVELOPMENT

Facility / Wildlife Habitat	Mine Construction Camp Housing and Parking	Mine Construction Access	Mine Construction Camp Water Supply and Pipeline	Open Pit [1]	Medicine Creek Mine Waste and Ash Disposal Embankments	South Meadow Mine Waste Embankments	Leachate Storage and Sedimentation Lagoons	Coal Blending Area	Low Grade Coal Stacking Area	Maintenance Buildings	Mine-waste conveyors	Coal conveyors	60 kv lines (waste and mine)	Mine road	Lower S.W. diversion drains	S.E. diversion drains	Upper S.W. diversion drain	North perimeter diversion drain	West perimeter diversion Drain	South run-off canal	North run-off canal	Minor diversion drains	North slide diversion drain	South slide diversion drain	TOTAL (hectares)	PERCENT ( ) OF LOCAL AREA AFFECTED
Aspen or mixed aspen-conifer habitat					17	22			<1 (0.13)			<1 (0.10)													39	1
Douglas-fir pinegrass habitat				46	153	336	3		11	17	8	3	27	15	1		1	<1 (0.16)	7	10	3	2	3	1	643	1
Ponderosa pine Douglas-fir bunchgrass habitat	5	1	<1 (0.10)	135	198	103	<1 (0.01)	38	7	8	9	2	9	13	2	<1 (0.23)		2			2	1			535	4
Riparian habitat				26		8			6				1							4	3	<1 (0.10)			39	4
Mid-elevation grassland				1	59	136	<1 (0.38)				5	3	1												217	4
Low elevation grassland				377		3	33		5	<1 (0.08)			4	8	1	<1 (0.10)			<1 (0.10)						409	61
Cultivated field							2							1		<1 (0.26)									3	<1
Rock					2								<1 (0.36)												3	<1
TOTAL	5	1	-	584	427	601	23	42	40	25	22	8	43	37	4	1	2	2	7	14	8	3	3	1		

[1] Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

Total area alienated by mine development - 1903 (ha)

TABLE 4-9

WILDLIFE HABITATS PREDICTED TO BE ALIENATED BY OFFSITE FACILITIES

Wildlife habitat / Facility	Main access road	Power plant site access road	60 kV transmission line from Rattlesnake substation to booster stn. II	Pit rim reservoir and dam	Pipeline, pit rim reservoir to canal and pump station	Pipeline from canal to make-up reservoir	Make-up water pipeline and pump station	Potential nursery	Environmental services lab	Site run-off holding pond	Relocated Hat Creek road	Meteorological tower	Pump house/ conveyor road	Overflow ditch to reservoir	Site drainage ditch	Finney Lake diversion canal	Hat Creek diversion canal	Headworks	Airstrip 'A'	Offloading area	Airstrip access road	60 kV substation (mine)	60 kV transmission line from Rattlesnake substation to booster stn. I	Rattlesnake substation	(hectares)	PERCENT (%) OF LOCAL AREA AFFECTED
Aspen or mixed aspen conifer habitat	4	1					2					2			<1 (0.24)										9	<1
Douglas-fir/ pinegrass habitat	44	6	2			5	13			1	5		4	<1 (0.11)	< (0.23)		16					1			95	<1
Engelmann spruce - lodgepole pine habitat	9																								9	<1
Ponderosa pine - Douglas-fir/ bunchgrass habitat	12					4					2			<1 (0.32)		1	8								28	<1
Riparian habitat				1				<1 (0.24)																	1	<1
Mid elevation grassland	23	5	1			3	6			2				<1 (0.20)	1										41	1
Low elevation grassland							15									8	10	6							35	<1
Sage brush/bluebunch wheatgrass grassland	<1 (0.33)			1	<1 (0.30)												7								9	1
Big sage grassland	14		6																46	3	6		21	3	98	<1
Brush habitat	7						<1 (0.36)																		7	<1
Cultivated field	2			7	<1 (0.10)		2	10	<1 (0.37)																21	1
Unclassified	1																								1	<1
TOTAL	116	10	9	9	-	12	38	10	-	3	7	2	4	1	1	9	42	6	45	3	6	1	21	3		

† Values are approximate to those in Table 3-1 due to the rounding to the nearest hectare and method of calculation. Maximum expected error in final total is ± 10 ha.

Total area alienated by offsite development - 384 (ha)

If the ash disposal scheme is excluded in both the selected project design and the original base engineering configuration in the wildlife report,[9] then there is a net increase of 80 ha alienated by plant-related facilities. The increase is mainly confined to the mid-elevation grasslands due to the relocation of the make-up water reservoir and dams. Increases are also evident for the Douglas-fir - pinegrass habitat and Ponderosa pine - Douglas-fir -bunchgrass habitat. Alienation of the Englemann spruce-lodgepole pine habitat was eliminated.

Mine-related alienation (Table 4-8) of the wildlife habitats has been reduced in all habitats except the Ponderosa pine - Douglas-fir - bunchgrass and riparian habitats. These habitats exhibited alienation increases of 90 and 14 ha, respectively.

The offsite facilities (Table 4-9) alienation of wildlife habitats follow a slightly different trend than discussed above for plant and mine-related facilities. Six wildlife habitats are alienated to a greater degree, while five habitats exhibit large decreases. The increases are generally minor with the Douglas-fir -pinegrass habitat with the largest increase, i.e., 10 ha. Decreases range from a high of 81 ha in the low elevation grassland to a reduction of 2 ha for the cultivated fields.

Of the above habitats alienated, the riparian, sagebrush, Douglas-fir - bunchgrass, low elevation grassland and cultivated fields have the highest capability for wildlife. In general, the alienation of these habitats are unaltered or decreased.

TABLE 4-10

WETLAND LOST AS A RESULT OF THE OPERATION AND CONSTRUCTION OF HAT CREEK PROJECT FACILITIES

Wetland Type		Operation				Construction					
	Facility	Open Pit, Mine, Road and Drained Area	Upper and Lower Diversion and Finney Creek Diversion	Mouth Meadows Dump	Water Supply Reservoir	Make up Water Pipeline	Powerplant	Operation Total	Construction Total	Project Total	Percent[1]
A. Temporary and ephemeral	Number of wetlands	6	1	2	1			10		10	20
	Area (ha)	5.09	0.04	1.61	0.03			6.77		6.77	54.6
	Edge (km)	2.38	0.09	0.88	0.03			3.38		3.38	35.3
B. Semi-permanent	Number of wetlands	7	9	1	1	2		18	2	20	14.5
	Area (ha)	1.46	0.6	0.14	0.47	0.90		2.67	0.90	3.57	23.9
	Edge (km)	1.29	0.81	0.19	0.26	0.56		2.55	0.56	3.11	14.9
C. Permanent with edge vegetation	Number of wetlands		3	5			1	8	1	9	20
	Area (ha)		0.42	1.29			1.05	1.71	1.05	2.76	12.9
	Edge (km)		0.45	1.16			0.72	1.61	0.72	2.33	15.1
D. Permanent without vegetation	Number of wetlands	12	2	2		1		16	1	17	20
	Area (ha)	13.54	0.22	0.16		2.10		13.92	2.10	16.02	12.1
	Edge (km)	5.36	0.34	0.30		1.17		6.0	1.17	7.17	16.5
E. Saline	Number of wetlands		2					2		2	2.7
	Area (ha)		0.14					0.14		0.14	2.8
	Edge (km)		0.20					0.20		0.20	2.3
F. Bog	Number of wetlands				1			1		1	3.2
	Area (ha)				0.55			0.55		0.55	2.7
	Edge (km)				0.34			0.34		0.34	2.5
Subtotal B+C+D	Number of wetlands	19	14	8	1	3	1	42	4	46	17.2
	Area (ha)	15.0	1.24	1.59	0.47	3.0	1.05	18.30	4.05	22.35	13.3
	Edge (km)	6.65	1.6	1.65	0.26	1.73	0.72	10.16	2.45	12.61	15.8
Total	Number of wetlands	25	17	10	3	3	1	55	4	59	13.9
	Area (ha)	20.09	1.42	3.2	1.05	3.0	1.05	25.76	4.05	29.81	14.5
	Edge (km)	9.03	1.89	2.54	0.63	1.73	0.72	14.08	2.45	16.54	14.8

[1] Percentage of the Hat Creek site study area totals (from Table 4-5, Wildlife Report).

4.2 WILDLIFE - (Cont'd)

Table 4-10 represents the number of wetlands, area and edge distance of wetlands alienated by the construction and operation of the project facilities. The selected project design has only minor additional impacts than that originally anticipated (Table 5-40 Wildlife Report). The drainage of the area west of Open Pit No. 1 has the most noticeable effect, where seven additional wetlands are affected. However, this only represents a total increase in area of 0.6 ha. The effect on the important semi-permanent, permanent with edge vegetation and permanent without edge vegetation habitats remains stable. The overall impact to wetlands has decreased in numbers, area and edge by 11, 8 ha and 4 km, respectively.

(b) Waste Disposal

The impacts to wildlife are expected to be reduced by the new project design. This is explained below.

Firstly, the wet ash disposal scheme has been abandoned and replaced by a dry ash disposal scheme. This eliminates the chance of wildlife contact, chiefly waterfowl, with the low quality ash leachate waters. Secondly, all surface and seepage waters will be collected and stored in lagoons. The total size of the lagoons is 23 ha. The use by waterfowl, other birds and ungulates will be greatly reduced by the relatively small size of each of these lagoons and proximity to operational activities. Fencing and screening will also effectively reduce wildlife use.

The possibility of ungulates digesting contaminated vegetation will be reduced or eliminated as indicated in Section 4.1(ii) and by adequate fencing of all disposal sites.

4.2 WILDLIFE - (Cont'd)

(c) Indirect Changes

No indirect changes are expected to occur as a result of the selected project description. The indirect changes originally discussed[9] are still valid.

(d) Decommissioning

Previous discussions[9] remain valid. The only major change in the decommissioning plan is the decision to limit water collection in Open Pit No. 1 so that no lake is formed. Originally, it was anticipated that the pit would be filled with water after the completion of mining. However, the use of this area by wildlife, particularly waterfowl, was felt to be a minimal benefit. Consequently, no resultant impact is anticipated due to the loss of this water source. If water be allowed to accumulate in the pit, BEAK[11] estimates toxic leachates from the Medicine Creek waste dumps may reach the pit. Due to the accumulation of low quality leachates, this may have negative impacts on waterfowl or ungulates if they utilize the area.

4.3 FORESTRY

(a) Direct Alienation

The discussion of the effects of project description changes on the forestry resource required a complete revision of the analysis in Sections 4.3 and 5.0 of the Forestry Report.[1] However, no lengthy discussion of the revised tables is felt necessary, since most of the information contained within them is self-explanatory and is mainly used to develop the forestry loss figures. Additionally, much of the information discussed in the text of Section 4.3 is still valid, only the figures have changed. The original sections on ash disposal schemes can be ignored since they are not viable options under the selected project description.

4.3 FORESTRY - (Cont'd)

Considering these aspects, a brief summary of Tables 4-11 to 4-18 is presented with a comparison table of the original and selected project descriptions.

Tables 4-11 through 4-18 give the merchantable volume, productive forest area and total annual increment lost due to construction of the plant, mine and offsite facilities. In order to compare these figures with the original project description, Table 4-19 was developed. In all cases, the impact on the forestry resource is less due to construction design changes. For example, the total alienation by all project facilities is reduced by 1053 ha, 63007 m^3 and 1521 m^3 for productive forest area, merchantable volume and total annual increment, respectively. This represents an approximately 40 percent reduction in the impact to forestry from the construction design changes.

Tables 4-11, 4-14 and 4-16 show the amount of merchantable volume by species alienated by the plant, mine and offsite facilities. In general, Douglas-fir is affected to the greatest degree for all facility types. For site productivity (Tables 4-12, 4-15 and 4-17), very little good site is alienated (10.9 ha). Poor site is alienated to the greatest extent (1364.3 ha), while 195.9 ha of medium site is alienated.

4.4 AGRICULTURE

The format and content of this section requires explanation since it contains significant differences compared to the previous sections. The changes in the earlier sections were due only to changes in the base engineering configuration and air emissions. However, agriculture required corrections to the inventory report that had ramifications to the impact assessment. These changes are mainly due to corrections to the climate capability mapping as a result of government agency comments.

TABLE 4-11

SITE SPECIFIC STUDY AREA: MERCHANTABLE VOLUME *

BY SPECIES: PLANT AND RELATED FACILITIES

Species	Merchantable Volume	
	Cubic Metres	Cunits
Douglas-fir	2 041.3	720.9
Red cedar	3.3	1.2
Hemlock	0.7	0.2
Balsam	32.8	11.6
Spruce	328.7	116.1
White pine	2.0	0.7
Lodgepole pine	4 142.3	1 462.8
Yellow pine	13.1	4.6
Deciduous (Aspen, Birch and Cottonwood)	4.6	1.6
TOTAL	6 568.8	2 319.7

* Close Utilization Standards

TABLE 4-12

SUMMARY OF PRODUCTIVITY: PLANT SITE

(SELECTED ENGINEERING CONFIGURATION)

	Area		Mean Annual Increment		Total Annual Increment	
Site Class	Hectares	Acres	m^3/ha	Cunits/Ac	m^3	Cunits
Medium	68.9	170.2	2.1	0.30	145	51
Poor	40.9	101.0	1.3	0.18	53	18
TOTAL	109.8	271.2			198	69

TABLE 4-13

AREA, VOLUME, INCREMENT SUMMARY FOR PLANT SITE

Option	Total Area		Productive Forest		Merchantable Volume *		Total Annual Increment	
	Hectares	Acres	Hectares	Acres	Cubic Metres	Cunits	Cubic Metres	Cunits
Base Engineering Configuration	246.1	607.9	109.8	271.2	6 568.8	2 319.7	296	105

• Close Utilization Standards

TABLE 4-14

SITE SPECIFIC STUDY AREA: MERCHANTABLE

VOLUME* BY SPECIES FOR MINE AND RELATED FACILITIES

Species	Merchantable Volume	
	Cubic Metres	Cunits
Douglas-fir	64 609.7	22 816.9
Red cedar	88.5	31.3
Hemlock	4.8	1.7
Balsam	263.1	92.9
Spruce	2 398.2	846.9
White pine	95.7	33.8
Lodgepole pine	1 038.5	366.7
Yellow pine	11 183.7	3 949.5
Deciduous (Aspen, Birch and Cottonwood)	58.2	20.6
TOTAL	79 740.4	28 160.3

* Close Utilization Standards

TABLE 4-15

SUMMARY OF PRODUCTIVITY: MINE AND RELATED FACILITIES

Site Class	Area		MAI Annual Increment		Total Annual Increment	
	Hectares	Acres	m^3/ha	Cunits/Ac	m^3	Cunits
Good	7.0	17.4	3.6	0.51	25	9
Medium	92.1	227.5	1.7	0.24	157	55
Poor	1 233.8	3 047.5	1.0	0.14	1 234	427
TOTAL	1 332.9	3 292.4			1 416	491

TABLE 4-16

SITE SPECIFIC STUDY AREA: MERCHANTABLE

VOLUME* BY SPECIES: OFFSITE AREAS

Species	Merchantable Volume	
	Cubic Metres	Cunits
Douglas-fir	6 539.2	2 309.3
Red cedar	19.2	6.8
Hemlock	-	-
Balsam	36.9	13.0
Spruce	227.8	80.4
White pine	6.9	2.4
Lodgepole pine	308.6	109.0
Yellow pine	281.5	99.4
Deciduous (Aspen, Birch and Cottonwood)	261.4	92.3
TOTAL	7 681.5	2 712.6

* Close Utilization Standards

TABLE 4-17

SUMMARY OF PRODUCTIVITY: OFFSITE FACILITIES

	Area		Mean Annual Increment		Total Annual Increment	
Site Class	Hectares	Acres	m^3/ha	Cunits/Ac	m^3	Cunits
Good	3.9	9.7	3.6	0.51	14	5
Medium	34.9	86.2	1.7	0.24	59	21
Poor	89.6	221.3	1.0	0.14	87	31
TOTAL	128.4	317.2			160	57

TABLE 4-18

SUMMARY OF SITE SPECIFIC INVENTORY

Facility	Total Area	Productive Forest	Merchantable Volume*	Total Annual Increment	Weighted MAI
	Hectares	Hectares	Cubic Metres	Cubic Metres	m^3/ha
Base Engineering Configuration	2 833.2[1]	1 571.1	93 990.7	1 774.0	1.12

* Close Utilization Standards

The weighted MAI for the Botanie PSYU is 1.329 m^3/ha.

[1]This total differs from Table 3-1 because of the addition of a 20 metre buffer strip around all facilities.

TABLE 4-19

COMPARISON OF THE ORIGINAL AND SELECTED PROJECT DESCRIPTIONS

Project Facility	Original Project Description			Selected Project Description			Difference		
	Area[1] (ha)	Volume[2] (m^3)	Total Annual Increment (m^3)	Area (ha)	Volume (m^3)	Total Annual Increment (m^3)	Area (ha)	Volume (m^3)	Total Annual Increment (m^3)
Plant and related facilities	615.7	26 701.6	1203.0	109.8	6 568.8	198.0	-505.9	-20 132.8	-1005.0
Mine and related facilities	1847.9	120 148.0	1893.0	1332.9	79 740.4	1416.0	-515.0	-40 407.6	-477.0
Offsite facilities	160.7	10 148.5	199.0	128.4	7 681.5	160.0	-32.3	-2 467.0	-39.0
TOTAL	2624.3	156 998.1	3295.0	1571.1	93 990.7	1774.0	-1053.2	-63 007.4	-1521.0

[1] Productive forest area.

[2] Merchantable volume.

[3] Buffer strip area.

4.4 AGRICULTURE - (Cont'd)

The original assessment procedure[2] did not require the production of a probable use maps for the eastern half of the site specific study area. The determination of impacts and the credibility of any statements made about the potential impacts would be greatly enhanced. This map is contained in Appendix B.

In addition, certain clarifications on irrigated land and water use decisions were requested by the Thermal Division, B.C. Hydro and Power Authority. These were concerned with possible reallocations of water for enhancement of probable irrigated lands and reclamation use. These are contained in Appendix C.

Utilizing the above information, impacts due to the selected engineering design and air emission changes were developed similar to the previous sections of this document.

(a) Direct Alienation - Construction and Operation

Alienation of probable irrigated land and rangeland is shown in Tables 4-20 and 4-21. Alienation of probable use is broken out on the basis of individual farm units. Tables 4-20 and 4-21 present this breakdown by farm unit and "open" and closed" alienation. "Open" alienation relates to project activities that do not completely alienate the land from agricultural use, e.g. buried pipelines and transmission lines, while "closed" represents project activities that entirely eliminate future agricultural use.

The alienation of deeded and leased irrigated land in the probable use case due to the selected project design is 168.4 ha (Tables 4-20 and 4-21). The majority of this amount is attributable to probable irrigated land which has potential for corn production.

TABLE 4-20

OPEN LAND ALIENATION - PROBABLE USE
SITE SPECIFIC STUDY AREA
BASE SCHEME SUMMARY

Land Status	Project Activity	"OPEN" Alienation by Farm Unit (ha)							Unclass	Total
		4[1]	5	6	7	8	9	13		
Deeded and leased irrigated land	C		0.2							0.2
	O		10.1		0.1		3.8	4.9	2.2	21.1
	M		1.9	0.1	1.4				0.1	3.5
	P		1.5							1.5
	I									
	Σ		13.7	0.1	1.5		3.8	4.9	2.3	26.3
Deeded and leased rangeland	C									
	O		10.6		0.2	15.7	15.9	4.9	3.2	50.5
	M	1.6	5.7	8.0	1.1				0.7	17.1
	P		20.5							20.5
	I									
	Σ	1.6	36.8	8.0	1.3	15.7	15.9	4.9	3.9	88.1
Permit rangeland	C									
	O					8.9				8.9
	M									
	P									
	I									
	Σ					8.9				8.9
Total "OPEN" alienation	C		0.2							0.2
	O		20.7		0.3	24.6	19.7	9.8	5.4	80.5
	M	1.6	7.6	8.1	2.5				0.8	20.6
	P		22.0							22.0
	I									
	Σ	1.6	50.5	8.1	2.8	24.6	19.7	9.8	6.2	123.3

[1] *Farm unit number, see Figs. 5-2[2] and B1-1 for location.*

Legend: C = Construction
O = Offsites
M = Mine
P = Plant
I = Indirect

TABLE 4-21

CLOSED LAND ALIENATION - PROBABLE USE
SITE SPECIFIC STUDY AREA
BASE SCHEME SUMMARY

Land Status	Project Activity	"CLOSED" Alienation by Farm Unit (ha)							Unclass	Total
		4[1]	5	6	7	8	9	13		
Deeded and leased irrigated land	C		8.1							8.1
	O	3.2	32.1		14.0		3.6		1.8	54.7
	M		18.4	9.8	3.1				11.7	43.0
	P		1.2			7.3				8.5
	I		25.2		1.2				1.4	27.8
	Σ	3.2	85.0	9.8	18.3	7.3	3.6		14.9	142.1
Deeded and leased rangeland	C		77.6							77.6
	O	14.9	103.2	5.3	20.4	36.1	12.8	3.1	8.5	204.3
	M	103.0	639.4	810.0	88.4				234.9	1875.7
	P		156.2			36.0				192.2
	I	6.8	115.6	67.0	11.4				6.1	206.9
	Σ	124.7	1092.0	882.3	120.2	72.1	12.8	3.1	249.5	2556.7
Permit rangeland	C									
	O					2.9	10.7		15.3	28.9
	M									
	P						42.0			42.0
	I						1.3			1.3
	Σ					2.8	54.0		15.3	72.1
Total "CLOSED" alienation	C		85.7							85.7
	O	18.1	135.3	5.3	34.4	38.9	27.1	3.1	25.6	287.8
	M	103.0	657.8	819.8	91.5				246.6	1918.7
	P		157.4			43.3	42.0			242.7
	I	6.8	140.8	67.0	12.6		1.3		7.5	236.0
	Σ	127.9	1177.0	892.1	138.5	82.2	70.4	3.1	279.7	2770.9

[1] Farm unit number, see Figs. 5-2[2] and 81-1 for location.

Legend: C = Construction
O = Offsites
M = Mine
P = Plant
I = Indirect

4.4 AGRICULTURE - (Cont'd)

The amount of alienated irrigated land, 168.4 ha, is about 6 percent of the total land alienated, 2894.2 ha.

The alienation of deeded and leased rangeland in the probable use case represents the greatest area alienated by the selected project design. Combined a total of 2644.8 ha is alienated. This is approximately 90 percent of the total land alienated.

Permit rangeland is only affected to a small degree, 8.9 ha of open alienation and 72.1 ha of closed alienation.

In all of the above cases, the development of the mine related facilities results in the greatest alienation (Tables 4-20 and 4-21).

Table 4-22 compares the effects of project development on the types of land status for the probable use case for the original base scheme and the selected project design. It is evident that the total project alienation has been reduced 24 percent by the selected project design. Most of this reduction stems from a reduced impact to closed alienation for all land status categories. Open alienation shows a slight increase of 93.9 ha to 123.3 ha as a result of the selected project design. Deeded and leased rangeland are responsible for the majority of this increase. Deeded and leased irrigated land shows only a 3.6 ha increase for open alienation.

(b) Waste Disposal

Previous discussions on waste disposal still are valid.[2] It is probable that the impact due to waste disposal will be less with the selected project design because of less land alienated. However, impacts due to trace elements still apply. The updated

TABLE 4-22

LAND ALIENATION COMPARISON BETWEEN ORIGINAL
BASE ENGINEERING DESIGN AND SELECTED ENGINEERING DESIGN
PROBABLE USE AGRICULTURE

Land Status		Original Base Engineering Design (ha)	Selected Engineering Design (ha)	Difference (ha)	Percent Change
Deeded and leased irrigated land	Open	22.7	26.3	+3.6	+16
	Closed	250.9	142.1	-108.8	-43
Deeded and leased rangeland	Open	51.8	88.1	+36.3	+70
	Closed	3026.3	2556.7	-469.6	-16
Permit rangeland	Open	19.4	8.9	-10.5	-54
	Closed	353.7	72.1	-281.6	-80
Total alienation	Open	93.9	123.3	+29.4	+31
	Closed	3630.9	2770.9	-860.0	-24

trace element information[18] indicates that no impact is expected to drinking water quality or accumulation in vegetation.

(c) Noise

Previous discussions on noise impact remain valid.[2]

(d) Decommissioning

This phase may change due to ongoing reclamation studies[11,12,13] and the loss of possible irrigation water due to the elimination of Site 2 storage reservoir from the selected project design. This reduces the beneficial effects by reducing the amount of water available for irrigation to 2200 ha.m/a assuming the availability of Thompson River water.[10] The location of the make-up water reservoir may interfere with present and probable irrigation use.

SECTION 5.0 - IMPACT OF AIR EMISSION CHANGES ON THE LAND RESOURCES

Numerous changes have occurred in design criteria for the control of air emissions from plant and mine operations. These changes have evolved due to benefit/cost analyses, an improved information base and the addition of new information. The choices and information are summarized below:

1. 244 m/MCS stack chosen.

2. Two natural draft hyperbolic cooling towers chosen.

3. Refinement in the coal quality analysis and therefore reduction of some of the stack emission rates.

4. Seven additional trace elements analysed.

5. Revision in the mine dust fugitive emissions.

6. Receipt of revised Acid Rain[15] report.

The first two changes have already been considered and analysed in all Land Resources reports. Consequently, only changes as a result of the other four revisions would affect the initial impact assessments.

Table 5-1 shows the contaminants reviewed, their previously assessed ambient concentrations and their new ambient concentrations.

It is evident from this table that most elements show a reduction in both emission rate and ambient concentration. Where increases occur they are generally minor. Fluorine appears to be the only element that exhibits an increase of 0.23 to 1.8 $\mu g/m^3$ maximum

TABLE 5-1

COMPARISON OF THE OLD AND NEW EMISSION VALUES FOR THE 244 m/MCS SYSTEM WITHIN THE 25 km RADIUS OF THE PLANT SITE

Contaminants Reviewed	Original Values		New Values	
	Emission Rate[1] kg/day	Ambient Conc. 24-hour Max. µg/m³	Emission Rate kg/day	Ambient Conc. 24-hour Max. µg/m³
Sulphur Dioxide	324 768	622[2]	312 000	622[3]
Particulates (TSP)[5]	40 000	32	34 400	28
Oxides of Nitrogen	207 248	5.8[4]	165 000	4.7[4]
Arsenic	17.2	0.03	17.0	0.014
Cadmium	0.35	0.00025	0.21	0.00017
Chromium	5.20	-	3.2	0.0026
Copper	5.93	-	26.0	0.021
Fluorine	281	0.23	2300	1.8
Lead	4.36	0.004	5.1	0.0041
Mercury	7.07	0.01	4.0	0.0032
Vanadium	16.1	-	9.9	0.008
Zinc	12.9	0.005	16.0	0.013
Beryllium	Not Assessed	Not Assessed	0.29	0.00023
Boron	"	"	28.0	0.022
Molybdenum	"	"	3.5	0.0028
Selenium	"	"	5.9	0.0047
Thorium	"	"	0.19	0.00015
Strontium	"	"	5.5	0.0044
Uranium	"	"	0.67	0.00054

1 Based on datum coal values.

2 3-hour maximum ambient concentration (µg/m³).

3 The effect of MCS will keep constant.

4 Annual ambient concentration (µg/m³).

5 Total suspended particulates.

for a 24-hour period. This has the potential to increase the impact on both the wildlife and forestry resources. Other trace elements such as copper, lead and zinc exhibit slight increases in emission rate, but the 24-hour ambient concentration maximums are quite low. However, these will be analysed in Section 5.1(e).

Following a review of Table 5-1, discussions held with representatives from Environmental Research and Technology, Inc. (ERT) and James F. Maclaren Ltd., and a review of new information[18] provided a basis to predict any changes in impacts due to air emissions. These discussions indicated that most elements would have impacts similar or less than those originally anticipated. The only area of concern dealt with the high levels of fluorine being emitted from the powerplant. This concern will be discussed in greater detail in Section 5.1(e).

Elements that exhibit values similar or less than those originally assessed are briefly discussed below.

5.1 POWERPLANT EMISSIONS

(a) Sulphur Dioxide

All Land Resources reports analysed the possible impacts of sulphur dioxide (SO_2) on their respective disciplines. This was done for three control systems, 366 m/FGD, 366 m/MCS and 244 m/MCS. Therefore since the selected control system (244 m/MCS) has already been analysed, it is felt the 244 m/MCS impact assessment is still valid at the local scale. In addition, a reduced synergistic effect between SO_2 and NO_x because of a reduction in NO_x emissions is anticipated not to affect the original impact assessment.

Regional impacts discussed in Land Resources reports are also valid, although ERT's Acid Rain[15] report indicates a 4-fold increase to annual averaged SO_2 deposition rates. For example,

5.1 POWERPLANT EMISSIONS - (Cont'd)

the isopleth exhibiting the maximum deposition rate changes from 10 $g.m^{-2}$ sec^{-1} x 10^{-9} to 40 $g.m^{-2}$ sec^{-1} x 10^{-9}.[15,21] Other isopleths reflected similar increases. These values are still well below those thought to cause injury.

(b) Acid Precipitation

The implications of acid rain were originally assessed to have an ambivalent impact on the land resources.[16] A review of the new ERT Acid Rain[15] report substantiates this conclusion. Reductions in pH were calculated for annual short-range and long-range transport. The average pH of the precipitation was 4.85 and 4.67, respectively. Precipitation pH values in this range are widely represented in the literature with no evidence to impacts on the terrestrial communities.

(c) Oxides of Nitrogen

Previous impact assessments[1,2,8,9] remain valid despite a reduction in the quantity of NO_x expected to be emitted. Consequently, previous impact assessments represent conservative values for the Physical Habitat and Range Vegetation, Wildlife and Agriculture Land Resource reports.

(d) Particulates (TSP)

Previous impact assessments[1,2,8,9] remain valid, although a slight increase in TSP emissions (Table 5-1) is predicted. No evidence is available to suggest that wildlife or vegetation would be affected at these levels.

(e) Trace Elements

The original assessments[1,2,8,9] of the impact of trace elements based on the previous trace element analysis[19] were reviewed because of several factors. New information published

5.1 POWERPLANT EMISSIONS - (Cont'd)

since 1977 may indicate important findings on effects of trace elements on plants and animals. Seven additional trace elements were analyzed, and new trace element emission rates have been determined.

A review of new information available for trace elements and the possible impacts[18] indicates that all trace elements except fluorine are within levels not expected to affect vegetation, soils or wildlife during the life of the plant (35 years). All trace elements reviewed did not exceed either Canadian or United States drinking water standards for livestock.[18] Soil accumulations over 35 years only amounted to a small percentage increase over existing soil levels. In addition many of these trace elements are effectively tied up due to the alkaline nature of most soils in the Hat Creek area. Therefore on a regional scale, based on deposition rates, no impacts are anticipated to soil, vegetation or wildlife.

The local scale assessments made in the Land Resources reports remain valid.[1,2,8,9] These assessments indicated that only fluorine impacts on forestry need be further addressed (Section 6.3).

Comments made in the original impact assessments[1,2,8,9] are still relevant to trace elements and should be considered valid especially with respect to monitoring.

5.2 COOLING TOWER EMISSIONS

Two natural draft towers is the selected cooling tower design. The previous assessments evaluated four cooling tower designs, of which two natural draft towers was one. Of these four designs, the two natural draft towers had the lowest maximum solids deposition rate (4717 $kg/km^2/a$).[17]

5.2 COOLING TOWER EMISSIONS - (Cont'd)

In all cases the deposition rate would drop to 560 kg/km^2/a within 3 km of the towers. All four designs result in the same amount of solids being emitted; the difference is in the pattern of deposition. Natural draft cooling towers disperse the solids over a wider area than other tower designs, resulting in a greater area being affected by a lower maximum deposition rate.

The previous impact assessments for the Land Resources[1,2,8,9] remain valid for the selected case.

5.3 IMPACT OF FUGITIVE DUST EMISSIONS FROM THE MINE ACTIVITIES

(a) Fugitive Dust Emissions

The original estimates of fugitive dust emissions from the mine and related facilities were based on an extremely "worst case" situation. Since that time, several factors have come to light that significantly alter the original values. Specifically these changes are as follows:

1. Knowledge that reclamation procedures are effective due to revegetation studies.

2. Mine plan changes.

3. Technical advances in determination of particle size distribution.

4. Effects of terrain (certain emissions occur below ground level) in the open pits.

5. Meteorology (moderate wind speeds represents a worse case condition, not low wind speeds).

These changes are discussed in detail in the report "A Re-evaluation of Air Quality and Climatic Effects of the Proposed Hat Creek Project".[21] The aforementioned states the following with respect to expected concentrations:

> "It is clear that in the immediate vicinity of any dust producing operation (within a few feet) high concentrations will be observed. However, our best judgment in light of the previous discussions and the CMJV analysis is that concentrations outside of the pits, at distances greater than half a kilometre from these major sources, should fall below the guideline values of 60 $\mu g/m^3$ for annual concentrations and 150 $\mu g/m^3$ for 24-hour maximum concentrations."

These conclusions represent a significant reduction in the expected levels of fugitive dust emission, both with respect to ground-level concentrations and distance from the major sources where possible impacts may occur.

Based on the above, the previous impact assessments for physical habitat and range vegetation,[8] wildlife,[9] agriculture[2] and forestry[1] are over-estimates of the possible impacts from fugitive dust emissions. Although all original reports had difficulty quantifying the possible impacts based on available data, the significant reduction of the original ground-level concentrations and area of impact should reduce the impacts or even eliminate any noticeable effects.

SECTION 6.0 - RESULTANT IMPACTS FROM CONSTRUCTION AND OPERATION DUE TO THE SELECTED ENGINEERING DESIGN

No changes in regional impacts resulting from construction and operation are expected as a result of the project changes. Previous impact assessments remain valid. An increase in local study area impacts will only occur as a result of changes in the expected impact of air emissions. Furthermore, the site specific study area is affected to the greatest degree due to project changes.

The possible changes in impacts due to the selected engineering design were assessed by comparing the previous impact assessments with the new project area alienations and design changes. Impacts resulting from waste disposal, indirect changes, and noise and harassment (wildlife) are discussed only where significant changes were anticipated in Section 4.0. Air emissions from both the mine and powerplant operation were discussed in Section 5.0 and will not be further analysed, except in the cases of agriculture and forestry, where economic assessments were made using this information.

6.1 PHYSICAL HABITAT AND RANGE VEGETATION

(a) Physical Habitat

(i) Direct Alienation

No change in the previously reported impacts to climate, landform and geology are anticipated from the construction and operation of the Hat Creek powerplant.[8]

Soil impacts exhibit a general decrease. This is the result of a reduction in the total alienation due to plant, mine and offsite development (Table 3-2).

Comparison of the original direct alienation figures (Tables 5-3 and 5-7)[9] and qualitative soil ratings (Table 5-2)[9] with the selected project design for the construction and operation of all facilities (Tables 4-1, 4-2 and 4-3) yielded the following results.

In addition to the overall reduction in impact (soil alienation), those soils classed as highly sensitive were affected to a lesser degree. The impact to all high sensitivity soils was reduced by approximately 105 ha. Similar reductions were evident for soils classed with moderate and low sensitivities. Therefore, it is reasonable to assume for direct alienation that the impact to soils due to the construction and operation of the Hat Creek Project is less than originally estimated.

(ii) Decommissioning

Changes to the original base engineering design with respect to decommissioning are not significant and therefore the previous impact assessment is still valid.

(b) Range Vegetation

(i) Direct Alienation

Table 6-1 compares the vegetation association alienations due to the selected engineering configuration with those of the original base engineering design. The vegetation sensitivity based on Table 5-11[8] is also shown.

TABLE 6-1

COMPARISON OF THE PREVIOUS AND PRESENT VEGETATION ASSOCIATION ALIENATIONS
DUE TO THE CHANGES IN ENGINEERING DESIGN

Vegetation Associations and Complexes Affected	Previous Vegetation Alienations (ha)	Present Vegetation Alienations (ha)	% Difference	Sensitivity
Engelmann spruce - grouse-berry - pinegrass assoc.	99.0	10.0	90	low
Douglas-fir - pinegrass assoc.	1173.0	701.0	40	low
Douglas-fir - bunchgrass assoc.	181.0	85.0	53	moderate
Douglas-fir - pinegrass - bunchgrass assoc.	500.0	562.0	increase	moderate
Ponderosa pine - bunchgrass assoc.	0.5	0	100	moderate
Riparian assoc.	27.0	14.0	48	high
Willow - sedge bog assoc.	10.0	4.0	60	high
Kentucky bluegrass assoc.	782.0	422.0	46	low
Bunchgrass - Kentucky bluegrass assoc.	24.0	63.0	increase	low
Sagebruch - bluebunch wheat-grass assoc.	424.0	387.0	9	high
Saline depression assoc.	3.0	3.0	0	moderate
Big sagebrush - bunchgrass assoc.	123.0	103.0	16	low
Cultivated fields	59.0	22.0	63	high
Bunchgrass - Kentucky bluegrass/saline depression complex	119.0	26.0	78	moderate
Douglas-fir - spirea - bearberry/Douglas-fir - pinegrass bunchgrass complex	115.0	92.0	20	high
Kentucky bluegrass/riparian complex	12.0	2.0	83	moderate
Douglas-fir - bunchgrass/ Douglas-fir - spirea - bearberry complex	0.5	0	100	moderate
TOTAL	3652.0	2496.0[1]		

[1] Total may vary from that in Table 3-1 because of rounding errors.

6.1 PHYSICAL HABITAT AND RANGE VEGETATION - (Cont'd)

This comparison indicates that an increase in area alienated occurs in the Douglas-fir - pinegrass - bunchgrass and bunchgrass - Kentucky bluegrass associations. However, this represents only a 0.4 and 1.5 percent increase respectively for the entire Hat Creek local study area. The remaining vegetation associations affected including those classed as high sensitivity decrease by up to 100 percent from the original alienation values. Many indicate a decrease in area alienated of greater than 40 percent.

It can be concluded from this analysis that the previous impact assessments represent conservative estimates of physical impact to vegetation. A reduction in impact to vegetation as a result of reduced land alienations occurs.

(ii) Decommissioning

No significant changes in the basic decommissioning plans will affect vegetation. The previous assessment remains valid.

6.2 WILDLIFE

(a) Wildlife Resources

The wildlife resources assessed include reptiles and amphibians, waterfowl, upland game birds, nongame birds, small mammals, furbearers and big game.

The expected impact on the above species groups should remain consistent with that previously assessed. A review of habitat alienation (Section 4.2(a)) indicates that only marginal changes occur. Alienation to most high capability habitat types

would be the same or decrease with the selected engineering configuration. The riparian and Douglas-fir - bunchgrass habitat types are the only high capability types exhibiting increases. However, these increases are only 22 and 105 ha, repectively. These increases represent only a small proportion of the area available in the local study area for the respective habitat type. Consequently, no significant increases in impact caused by direct alienation is expected. The overall resultant decrease in habitat alienation also is an important consideration.

Changes in the impacts resulting from noise, harassment, direct exploitation, waste disposal and indirect changes are not anticipated, since design changes have not altered significantly to cause a change in impact. A possible benefit to waterfowl is expected as a result of the elimination of wet ash disposal. The only area of concern is if Open Pit No. 1 collects toxic leachates from Medicine Creek waste dumps. Fencing to keep livestock and wildlife out, and screening to restrict use by waterfowl would be provided.

(b) Wildlife Resource Use

The wildlife resource use impacts deal mainly with impacts resulting from an influx of people into the Hat Creek area. This can increase hunter/days and human encounters with wildlife (noise and harassment). Factors such as loss of habitat are also considered.

Presently, no demographic changes from those initially indicated are expected. Section 5.2(a) suggests that the impact to the wildlife resources would remain consistent with the initial impact assessment. The previous impact assessment with respect to wildlife resource use is considered to be still valid.

6.3 FORESTRY

The same methodology was used to determine forestry impacts in this document as was used previously. A comparison of the "with" and "without" cases provided the framework to estimate impact.

The selected engineering design was used in Section 4.3 to generate the revised tables in order to estimate changes to the previous forestry impact assessment. This information was utilized to provide Tables 6-2 to 6-7 of this section to estimate the resultant impact these changes would have on the forestry resource.

(a) Construction Impacts

Construction impacts for the regional and local study area remain valid. Impacts due to construction in the site-specific study decrease as indicated in Table 6-2. This is the result of a smaller area of forest land alienated. Because less timber volume is lost, the total value of MAI lost decreases from $18 100.00 to $9757.00, a reduction of 46 percent. Table 6-3 shows the present worth of all future annual incomes from AAC, in perpetuity.

(b) Operational Impacts

Operational impacts incorporate impacts due to air emissions and forest land alienations. In order to assess the air emission impacts, the 244 m/MCS and "worse case" fluoride emissions were used, since these best represent the expected operating conditions. A review of the information on trace elements[18] reveals that fluoride emissions were based on the assumption that 63 percent of the total fluorine burned is released into the atmosphere. This is equivalent to that originally assessed in the Forestry report[1] in the "worst case" situation. The only major change is that the amount of fluorine in the coal has reduced from a mean of 137 ppm to 118 ppm.[18] This could effectively reduce the

TABLE 6-2

VALUE OF THE MAI CONTRIBUTION TO ALLOWABLE CUT
FROM THE SITE SPECIFIC AREA

Option	MAI (m^3)	Value per m^3	Total Annual Value
Base engineering configuration	1774	$5.50	$9757

TABLE 6-3

PRESENT WORTH OF ALLOWABLE ANNUAL CUT ON SITE SPECIFIC AREA
THAT WOULD BE LOST WITH THE PROJECT

Option	Annual Value	÷	Discount Rate	=	Present Worth of AAC in Perpetuity (k$)
Base engineering configuration	$9757		0.03		$325
			0.04		244
			0.05		195
			0.06		163
			0.08		122
			0.10		98
			0.12		81

predicted impact by 10 percent. However, a review of the standard deviations associated with the mean coal fluorine values[18] indicated a coefficent of variation of 25 percent. Consequently, it was felt that it was not valid to alter the forestry impact figures. In any case, the forestry impact values would represent the ultra-conservative case.

Table 6-4 presents the total annual value of the MAI lost from both air emissions and forest land alienations. The selection of the 244 m/MCS system indicates that for the "worst probable" case, a total annual MAI loss of $136 143.00 would possibly occur. Although the loss in the site-specific study area has already been accounted for in the AAC of the Botanie PSYU, the loss of $126 386.00 is the expected result of SO_2 and HF emissions.

Table 6-5 shows the present values of MAI losses for the 244 m/MCS, "worst probable" HF emissions and selected engineering configuration. The total value of the MAI losses ranges between $1.1 and $3.0 million depending on discount rate.

A comparison of the potential benefits to forestry without and with the Hat Creek Project considering a series of discount rates is given in Table 6-6. The benefits range from a high of $26 800 000 at 3 percent discount rate without the project to a low of $5 585 000 at a 12 percent discount rate with the project considering the 244 m/MCS and "worst probable" HF emissions. The benefits with the project are $278 000 and $70 000 at the 3 and 12 percent discount rates, respectively, greater than originally assessed.

Prediction of fume impacts on vegetation is not an exact science. Because of the many unknown or poorly understood factors, intangibles, synergisms and the highly variable responses

TABLE 6-4

TOTAL ANNUAL VALUE OF MAI LOSS FOR THE SELECTED ENGINEERING CONFIGURATION

Control Systems	Source of Loss	Worst Probable Case ($)
MCS-244	Site specific area	9 757
	HF emission effect	125 686
	SO_2 emission effect	700
	TOTAL	136 143

TABLE 6-5

PRESENT VALUE[1] OF MAI LOSSES THAT WOULD BE LOST FOR THE SELECTED ENGINEERING CONFIGURATION AND CONTROL SYSTEMS

Discount Rate	Worst Probable HF Emission
	SO_2 Control System
	MCS-244
0.03	3041
0.04	2602
0.05	2264
0.06	1996
0.08	1594
0.10	1316
0.12	1115

1 Values in k$.

TABLE 6-6

COMPARISON OF POTENTIAL BENEFITS TO FORESTRY IN THE HAT CREEK LOCAL STUDY AREA WITHOUT THE PROJECT AND WITH THE PROJECT CONSIDERING DISCOUNT RATE, SELECTED ENGINEERING CONFIGURATION SO_2 CONTROL SYSTEM, AND HF EMISSION LEVEL
(Values in k$)

Discount Rate	Without the Project	With the Project
	Total Potential Benefit	Worst Probable HF Emission
		SO_2 Control System
		MCS-244
0.03	26 800	23 759
0.04	20 100	17 498
0.05	16 080	13 816
0.06	13 040	11 044
0.08	10 050	8 456
0.10	8 040	6 724
0.12	6 700	5 585

to treatments as reported in the literature, the estimate of allowable annual cut lost and its annual value each year is at a confidence level of plus or minus one order of magnitude.[1]

Summary of impacts for construction and operation of the Hat Creek Project are summarized in Table 6-7. In order to simplify the total, only one discount rate was used. The impacts from the previous impact assessment are shown for comparitive purposes.

The volume shown in the total column in Table 6-7 represents the estimated volume of the current merchantable growing stock potentially impacted by the proposed Hat Creek Project. It is from this volume that premature mortality may occur from either plant construction or operation. This timber could be prelogged in the construction phase or salvaged in the operational phase. Merchantable timber not salvaged would count as a loss to forestry because of the project.

The MAI column predicts the loss of future tree growth that would result if the Hat Creek Project were implemented.

A comparison of the previous project impacts and those of the selected project design indicate a definite decrease in impact to the forestry resource. It is evident that this is due to a decreased forest land alienation in the site-specific study area. This is represented by a annual value MAI loss of $8343 or a 3 percent discounted benefit of $278 000 over the 35-year life of the plant, greater than that originally assessed.

(c) Decommissioning Impacts

There are no decommissioning impacts or benefits applicable to forestry.

TABLE 6-7

SUMMARY OF PROJECT IMPACTS BY AREA, VOLUME AND VALUE
FOR THE PREVIOUS AND SELECTED PROJECT DESIGNS

	Previous Project Design					Selected Project Design				
		Volume		Value			Volume		Value	
	Area (ha)	Total m^3 (k)	MAI m^3/a	Annual $	3% k$	Area (ha)	Total m^3 (k)	MAI m^3/a	Annual $	3% k$
Site specific study area - selected engineering configuration	4 320	157	3 290	18 100	603	2 833[1]	93	1 774	9 757	325
Emissions:										
SO_2 - MCS-244	N/A	191[2]	132[2]	700	15	N/A	191[2]	132[2]	700	15
HF - worst probable	34 390	1235[2]	22 900[2]	126 000	2701	34 390	1235[2]	22 900[2]	126 000	2701

[1] Buffer strip of 20 m results in higher value than shown in Table 3-1.

[2] Table 5-13, page 123[1].

6.4 AGRICULTURE

Changes in the engineering configuration resulted in significant changes to the agriculture impact assessment. A complete reassessment was carried out to predict the possible changes in impact resulting from engineering design alterations.

The basis for the agriculture impact assessment was the effect the Hat Creek Project would have on the Hat Creek basin beef industry. This was presented in both the impact on the carrying capacity and economic loss. In addition, the loss of present irrigated land and rangeland was assessed. These figures were used to determine the reduction in carrying capacity and dollars resulting from the development of the Hat Creek Project.

The same methodology and assumptions using the probable use analysis were employed in this analysis as were used to do the original impact assessment.[2] The following assessment represents a condensation of the analysis presented in Section 5.3 of the Agriculture report.[2]

The probable use analysis assumes maximum levels may never be reached (potential use analysis, Agriculture Report - Impact Assessment[2]). Constraints were applied that would lower the potential use to a realistic level considering the type of agricultural operation in Hat Creek and future trends. These constraints included the demand for feed by beef cattle, the availability of water for expanded irrigation, and the time required to improve certain range areas. The future feed demand of the beef industry was based on apparent industry trends ascertained from discussions with government and industry representatives and ranchers of the Hat Creek basin. The supply of feed for livestock was based on the composite of the production yields expected of the probable irrigated lands (winter feed) and rangelands (spring and summer feed) within Hat Creek basin. Information as to the amount and time of year that water would be available for irrigation was taken from Beak.[10] No analysis of the economic feasibility was undertaken. However, it is felt that the case presented, which takes into account

6.4 AGRICULTURE - (Cont'd)

the above considerations, is realistically possible and represents actual agricultural value.

(a) Summary of Impacts on Agriculture

Tables 6-8 and 6-9 provide a summary of impacts within the upper Hat Creek valley on an individual farm unit basis. The impacts tabulated include the land totally alienated by construction activities and land productivity reduced by SO_2/NO_2 emissions. These impacts do not include noise or barrier impact which remain unchanged.[2]

The total impacted probable irrigated lands in upper Hat Creek valley amount to 250.4 ha, about 15 percent of the total probable irrigated lands for the without the project case. The impact on rangeland, occurring only within upper Hat Creek valley, as shown in Table 6-9 is 2251.3 ha, about 4 percent of rangeland within the Hat Creek basin. Of this total, impacted deeded and leased probable grazing lands in upper Hat Creek valley amount to 2983.9 ha or 15 percent of the total deeded and leased probable grazing lands for the without project case. The alienation of permit land, 99.5 ha, is an extremely small percentage (4 percent) of the total basin permit area.

The above impacts represent an increase of 3 percent for total irrigated land, and a decrease of 6 percent for total deeded and leased probable grazing lands in the upper Hat Creek valley compared to the original project alienation. Alienation to permit rangeland was reduced by 238.4 ha.

(b) Agriculture Resource Projection with the Project for the Hat Creek Basin Beef Industry

The probable beef industry of Hat Creek basin and the associated farm unit activities were projected for the "with"

TABLE 6-8

SUMMARY OF IMPACTS[1] ON PROBABLE IRRIGATED LAND
UPPER HAT CREEK VALLEY
(ha)

Crop Type		Farm Unit Number[2] 1	2	3	4	5	6	7	8	Unclass	Total
Corn	D	-	-	-	-	-	-	5.7	-	7.3	13.0
	L	-	-	-	-	156.1[3]	-	-	-	-	156.1
Hay	D	2.6[3]	1.0[3]	1.5[3]	7.7[3]	0.4	-	11.2[4]	-	-	24.4
	L	-	-	-	-	-	-	-	-	-	-
All-season pasture	D	0.6[3]	0.2[3]	-	-	-	9.1[4]	6.8	-	-	16.7
	L	-	-	-	0.04[3]	-	-	-	2.9	-	2.94
Spring pasture	D	1.1[3]	0.6[3]	0.8[3]	6.2[3]	-	4.9	10.7	-	-	24.3
	L	0.5[3]	-	-	-	-	-	12.6	-	-	13.1
TOTAL		4.8	1.8	2.3	13.9	156.5	14.0	46.9	2.9	7.3	250.4

1 Includes "CLOSED" alienation and SO_2/NO_2 air emission impacts.

2 See Figs. 5-2[2] and B1-1 for location.

3 Impact from 244 m stack Meteorological Control Strategy Air Quality Model.

4 Includes impact due to reversion to grazing rating.

Legend: D = Deeded
L = Leased

TABLE 6-9

SUMMARY OF IMPACTS[1] ON PROBABLE RANGELAND
UPPER HAT CREEK VALLEY
(ha)

Grazing Rating[2]		Farm Unit Number[2]							
		4	5	6	7	8	9	Unclass	Total
	D	-	-	172.9	-	-	-	-	172.9
A	L	24.0	159.6	24.1	1.7	19.7	-	-	229.1
	P	-	-	-	-	28.6	-	-	28.6
	D	7.3	1.3	-	7.3[3]	-	-	33.1	49.0
B	L	4.4	10.5[3]	-	16.2	-	-	-	31.1
	P	-	-	-	-	-	-	-	-
	D	-	-	12.1[3]	0[3]	-	-	169.2	181.3
C	L	-	39.6	130.8	2.8	-	-	-	173.2
	P	-	-	-	-	-	-	-	-
	D	-	-	14.3	-	-	-	-	14.3
D	L	-	1.6	5.5	34.3	-	-	-	41.4
	P	-	-	-	-	-	5.7	-	5.7
	D	-	-	34.4	3.1	-	-	1.6	39.1
F	L	93.6	353.2[3]	3.0	2.5	-	-	-	452.3
	P	-	-	-	-	-	6.7	-	6.7
	D	0.7	-	33.0	0.1	-	-	-	33.8
G	L	8.2	252.7	345.2	25.1	7.3	-	-	638.5
	P	-	-	-	-	14.0	44.5	-	58.5
	D	-	-	-	-	-	-	-	-
H	L	-	0.6	-	-	4.0	-	-	4.6
	P	-	-	-	-	-	-	-	-
	D	-	-	23.1	-	-	-	-	23.1
RO	L	-	-	68.1	-	-	-	-	68.1
	P	-	-	-	-	-	-	-	-
TOTAL		138.2	819.1	866.5	93.1	73.6	56.9	203.9	2251.3

1 Includes "CLOSED" alienation and SO_2/NO_2 air emission impacts.

2 See Figs. 5-2[2] and B1-1 for location and description.

3 Includes impact due to reversion from irrigated rating.

Legend: D = Deeded L = Leased P = Permit

project case by subtracting project impacts from the probable "without" the project case.[2] The tabulation of probable use with the project case for irrigated land and deeded and leased rangeland of the upper Hat Creek valley by farm units is given in Tables 6-10 and 6-11, respectively.

(i) Base Irrigated Land

Combining the "with" case probable irrigated land (Table 6-10) for the upper Hat Creek valley with values for the lower Hat Creek valley, where no significant impact occurs, results in the probable irrigated lands with the project for the entire Hat Creek basin as shown in Table 6-12. This amounts to 16.7 km^2 or 3 percent less than the original project projections.[2]

(ii) Base Rangeland

The base rangeland for the "with" case, derived by subtracting the impacts from the "without" case, is shown in Table 6-13. The total base rangeland is reduced from 622 km^2 (240 mi^2) to 600 km^2 (232 mi^2); a 12 percent reduction of spring rangeland and a 2 percent reduction of summer rangeland would occur.

(iii) Feed Resources

Except for winter feed (Table 6-14) which remains constant, spring feed and summer feed generally increase as a result of a reduction in impact of the selected project description. For example, spring feed (Table 6-15) increased from 7664 AUM for the original project description[2] to 8306 AUM for the selected project description. Likewise, summer feed (Table 6-16) increased from 8740 to 8820 AUM. These represent

TABLE 6-10

PROBABLE USE WITH THE PROJECT - IRRIGATED LAND
UPPER HAT CREEK VALLEY
(ha)

Corp Type	Tenure	Farm Unit Number[1]											
		1	2	3	4	5	6	7	8	11 (I.R.)	14	Unclass	Total
Core	D	-	-	-	-	-	0.4	25.2	-	53.8	-	-	79.4
	L	-	-	-	-	92.4	-	-	-	-	-	-	92.4
	Σ	-	-	-	-	92.4	0.4	25.2	-	53.8	-	-	171.8
Hay	D	102.6	49.6	39.0	216.1	166.7	10.5	29.3	-	28.3	52.6	10.1	704.8
	L	-	-	-	-	9.7	-	-	-	-	-	-	9.7
	Σ	102.6	49.6	39.0	216.1	176.4	10.5	29.3	-	28.3	52.6	10.1	714.5
All-season pasture	D	23.7	9.9	-	0.8	5.3	5.9	33.6	-	-	-	-	79.2
	L	-	-	-	2.0	-	-	18.6	4.4	-	-	-	25.0
	Σ	23.7	9.9	-	2.8	5.3	5.9	52.2	4.4	-	-	-	104.2
Spring pasture	D	44.2	29.8	19.4	107.1	54.6	-	0.6	-	16.2	26.3	-	298.2
	L	18.9	-	-	-	36.4	-	26.7	-	-	-	-	82.0
	Σ	63.1	29.8	19.4	107.1	91.0	-	27.3	-	16.2	26.3	-	380.2
Total irrigated	D	170.5	89.3	58.4	324.0	226.6	16.8	88.7	-	98.3	78.9	10.1	1161.6
	L	18.9	-	-	2.0	138.5	-	45.3	4.4	-	-	-	209.1
	Σ	189.4	89.3	58.4	326.0	365.1	16.8	134.0	4.4	98.3	78.9	10.1	1370.7

[1] Refer to Figs. 5-2[2] and B1-1 for location.

Legend: D = Deeded
L = Leased

TABLE 6-11
PROBABLE USE WITH THE PROJECT - DEEDED AND LEASED RANGELAND
UPPER HAT CREEK VALLEY
(ha)

Grazing Rating	Tenure	Farm Unit Number[1]											
		1	2	3	4	5	6	7	8	11 (I.R.)	14	Unclass	Total
A	D	-	11.3	-	-	-	91.4	-	-	36.0	-	-	138.7
	L	18.6	23.9	125.1	48.0	846.5	51.6	1.9	162.4	-	-	-	1278.0
	Σ	18.6	35.2	125.1	48.0	846.5	142.8	1.9	162.4	36.0	-	-	1416.5
B	D	116.6	130.3	4.1	218.1	63.0	52.6	49.0	-	-	147.7	21.5	802.9
	L	16.2	120.6	68.4	1639.5	215.6	61.1	111.3	-	-	-	-	2232.7
	Σ	132.8	250.9	72.5	1857.6	278.6	113.7	161.1	-	-	147.7	21.5	3036.4
C	D	-	-	-	-	-	34.0	10.9	-	-	-	-	44.9
	L	-	-	-	-	2.5	40.4	72.5	-	-	-	-	115.4
	Σ	-	-	-	-	2.5	74.4	83.4	-	-	-	-	160.3
D	D	-	-	-	-	-	12.0	-	33.6	-	-	-	45.6
	L	-	-	-	-	-	77.1	56.4	-	-	-	-	133.5
	Σ	-	-	-	-	-	89.1	56.4	33.6	-	-	-	179.1
F	D	-	3.2	-	-	-	-	8.6	-	98.4	-	-	110.2
	L	22.7	1.6	39.7	975.2	305.6	12.4	16.5	1.2	-	-	-	1374.9
	Σ	22.7	4.8	39.7	975.2	305.6	12.4	25.1	1.2	98.4	-	-	1485.1
G	D	68.8	5.7	-	67.3	-	5.0	22.2	-	-	-	-	169.0
	L	279.2	210.1	293.8	716.6	1213.1	1316.9	426.5	395.4	-	-	2.8	4854.4
	Σ	348.0	215.8	293.8	723.9	1213.1	1321.9	448.7	395.4	-	-	2.8	4963.4
H	D	-	-	-	-	-	-	41.3	-	-	-	-	41.3
	L	-	-	25.1	12.9	42.7	123.4	-	406.4	-	-	-	610.5
	Σ	-	-	25.1	12.9	42.7	123.4	41.3	406.4	-	-	-	651.8
J	D	-	-	-	-	-	-	0.8	-	-	-	-	0.8
	L	-	-	-	85.4	17.0	9.3	-	-	-	-	-	111.7
	Σ	-	-	-	85.4	17.0	9.3	0.8	-	-	-	-	112.5
Rock outcrop and water bodies	D	28.3	17.4	-	-	-	-	-	-	-	-	-	45.7
	L	-	-	30.8	-	-	149.6	-	-	-	-	40.4	220.8
	Σ	28.3	17.4	30.8	-	-	149.6	-	-	-	-	40.4	266.5
Total rangeland	D	213.7	167.9	4.1	285.4	63.0	195.0	133.6	33.6	134.4	147.7	21.5	1399.9
	L	336.7	356.2	582.9	3477.6	2643.0	1841.6	685.1	965.4	-	-	43.2	10931.7
	Σ	550.4	524.1	587.0	3763.0	2760.0	2036.6	818.7	999.0	134.4	147.7	64.7	12385.6

[1] Refer to Fig. 5-1 (foldout) for location.[2]

Legend: D = Deeded
L = Leased

TABLE 6-12

PROBABLE USE WITH THE PROJECT
BASE IRRIGATED LAND
HAT CREEK BASIN
(km^2)

Crop Type	Upper Hat Creek Valley	Lower Hat Creek Valley	Total Basin
Corn	1.7	-	1.7
Hay	7.1	1.6	8.7
All-season pasture	1.0	0.5	1.5
Spring pasture[1]	3.8	1.0	4.8
TOTAL	13.6	3.1[2]	16.7

[1] Irrigated during May and first half of June.

[2] No significant loss of irrigated land in lower Hat Creek valley.

TABLE 6-13

PROBABLE USE WITH THE PROJECT
BASE RANGELAND
HAT CREEK BASIN
(km^2)

Grazing Rating[1]	Probable Without	Impact[2]	Probable With
Spring Range			
A	27	4	23
B	43	1	42
C	5	4	1
Sub total	75	9	66
Summer Range			
D	27	1	26
E	10	-	10
F	70	5	65
G	195	7	188
H	175	-	175
J	70	-	70
Sub total	547	13	534
TOTAL	622	22	600

1 See Table 5-8 for corresponding vegetation association.[8]

2 All impact on grazing in Hat Creek basin occurs in upper Hat Creek valley as shown in Table 6-9.

TABLE 6-14

PROBABLE USE WITH THE PROJECT
WINTER FEED
HAT CREEK BASIN BEEF INDUSTRY

Crop Type[1]	Area (ha)	Probable Productivity (Mg-ha^{-1})	Production (Mg)
Alfalfa grass	642	5.6	3595
Wetland hay	138	6.8	938
Alfalfa grass	90	9.0	810
TOTAL	870		5343
			or
		Animal units,	3360[2]
			or
		AUM,	23 520[2]

[1] Probable corn land, 170 ha, not included.

[2] Derived on the basis of a 7-month fall/winter season with a feed requirement of 1.59 Mg-animal unit^{-1}.

TABLE 6-15

PROBABLE USE WITH THE PROJECT
SPRING FEED
HAT CREEK BASIN BEEF INDUSTRY

Grazing Rating[1]	Area (ha)	Probable Carrying Capacity (ha-AUM [1])	Production[2] (AUM)
A	2300	0.62	3710
B	4200	1.23	3415
C	100	1.23	81
Spring pasture	480	0.6	800
All-season pasture	150	0.5[3]	300
TOTAL	7230		8306
			or
		Animal units,	4153[4]

---

1 See Table 5-8 for corresponding vegetation association.[8]

2 Assuming other seasons not limiting.

3 Carrying capacity proportioned evenly between spring and summer.

4 Derived on the basis of a 2-month spring season.

TABLE 6-16

PROBABLE USE WITH THE PROJECT
SUMMER FEED
HAT CREEK BASIN BEEF INDUSTRY

Grazing Rating[1]	Area (ha)	Probable Carrying Capacity (ha-AUM $^{-1}$)	Production[2] (AUM)
D	2 600	5	520
E	1 000	6	167
F	6 500	6	1083
G	18 800	6	3133
H	17 500	6	2917
J	7 000[3]	10	700
All-season pasture	150	0.5[4]	300
TOTAL	53 550		8820
			or
		Animal units,	2940[5]

---

1 See Table 5-8 for corresponding vegetation association.[8]

2 Assuming other seasons not limiting. Note that spring rangeland, not included, could also be used during the summer.

3 Includes rock outcrops and water bodies.

4 Carrying capacity evenly proportioned between spring and summer.

5 Derived on the basis of a 2-month spring season.

increases of 8 and 1 percent for spring and summer feed, respectively.

(iv) Beef Industry Composite

The preceding analyses for the three feed resource seasons are summarized in Table 6-17 for the "with" case. Spring resources would be lowered substantially by the project but as in probable use "without" the project the summer season would also impose limitations on the probable herd size of the Hat Creek basin beef industry assuming no assistance from the feed resources of the other seasons. However, using the same rationale as in the "without" case, there would still be sufficient spring and summer resources combined to match the potential of the winter feed resource, 3360 animal units. Therefore, in the "with" case, the scenario would still enter a winter limiting period as it did for the "without" case projection. Unless the purchase of additional winter feed became economic, 326 AUM of the probable spring feed production would remain undeveloped. It is logical that spring rangeland with the highest probable productivity, grazing rating A, would be improved in preference to rangeland with lower productivity, grazing ratings B and C. In this case, about 823 ha (2034 ac) of B and C rangeland would remain unimproved (not reseeded) which is 12 percent of the total base spring rangeland. Depending on economic tradeoffs it is also possible that spring pasture would cease to be irrigated once the productivity of the spring ranges was increased, with additional reseeded B and C rangeland substituted for this component of the feed resource.

TABLE 6-17

PROBABLE USE WITH THE PROJECT
SEASONAL RESOURCE SUMMARY
HAT CREEK BASIN BEEF INDUSTRY

Season	Production[1] (AUM)	Maximum Probable[1] Herd Size (Animal Units)
Winter (7 months)	23 520	3360
Spring (2 months)	8 306	4153
Summer (3 months)	8 820	2940

[1] Assuming no limitations or assistance from resources associated with other seasons.

The probable development of the spring feed resource, illustrated in Fig. 6-1, results from the consideration of the loss of spring rangeland alienated by the project and the increase of productivity of nonalienated spring rangeland due to reseeding. The present spring range production of 4153 AUM eventually approaches the probable maximum of 7980 AUM. Note that some of this development would be used during the summer season. The corresponding curve of projected herd size is also shown in Fig. 6-1, starting from the present size of 2080 animal units and approaching 3360. These curves are based on the same rationale as that used in the original project description (Agriculture report, pp. 138-139).[2]

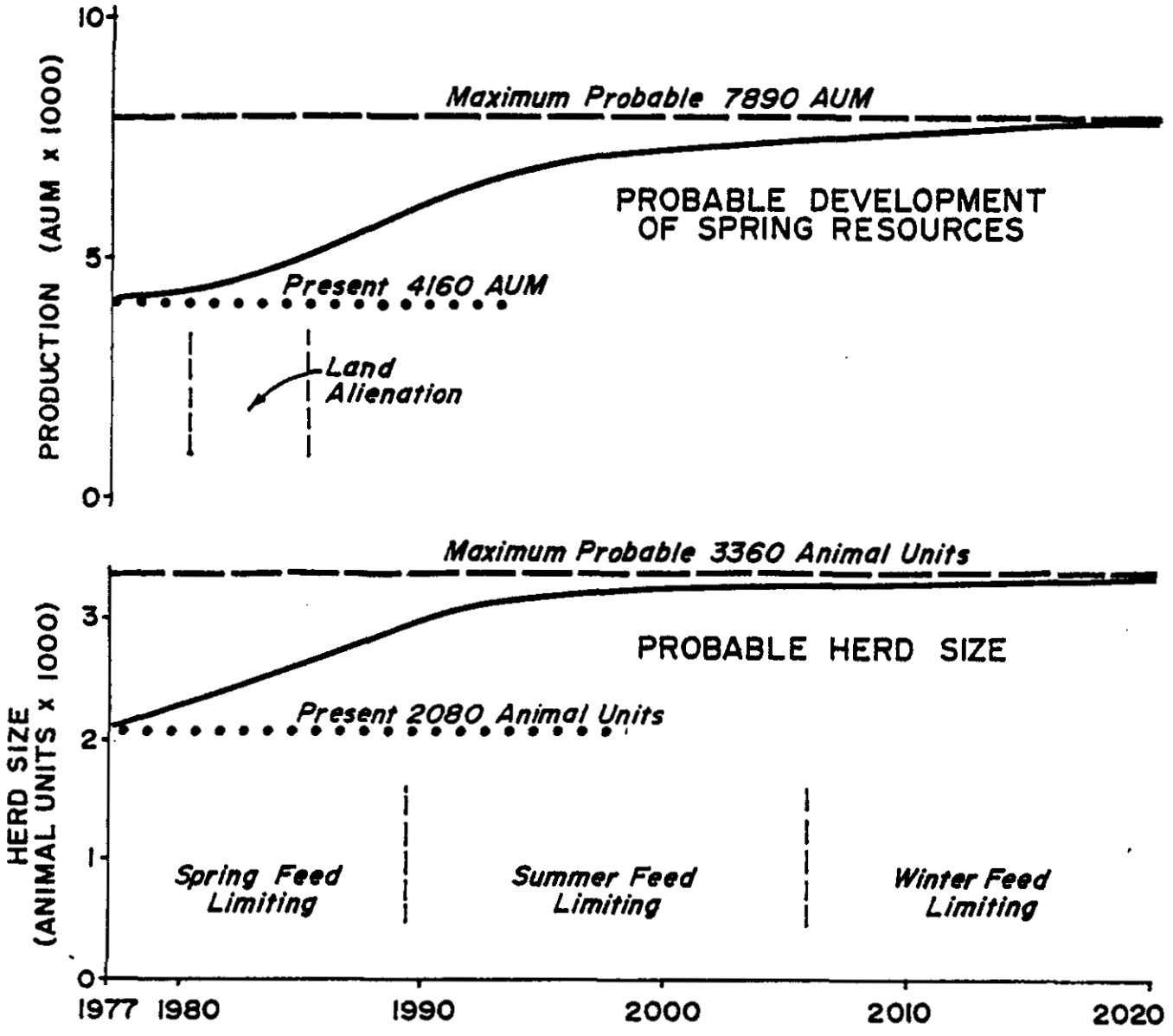


FIGURE 6-1
PROBABLE DEVELOPMENT WITH THE PROJECT SPRING RESOURCES PRODUCTION AND HERD SIZE VERSUS TIME HAT CREEK BASIN BEEF INDUSTRY

Alienation of spring rangeland would be the most significant factor in the determination of project impact on the herd size. This is due to the relatively large amount of alienation of this land category (12 percent) and the fact that this feed resource would be the factor controlling the growth of herd size. At the end of the land alienation period, the impact on spring production would also be about 12 percent or about 500 AUM and since spring feed would still be limiting at this time, the corresponding impact on herd size would therefore be about 250 animal unit months. This impact would become less severe with time as the maximum probable herd size of 3360 animal unit months (Fig. 6-1) is only 3 percent less than the size which would be reached without the project.

The production of corn silage in the basin and its use for possible backgrounding and finishing of cattle was not included as part of the basin resource model for reasons explained in the without case. If the probable corn land were developed, the estimated total production of 10 481 Mg (11,553 tons) of corn silage ($1.7\ km^2 \times 6165\ Mg\text{-}km^{-2}$, see Table 6-12 and Fig. 6-1) could provide the silage portion of a feed ration for a feedlot operation producing approximately 5800 head of beef cattle for slaughter each year (based on the silage requirement of $1.82\ Mg\text{-}animal^{-1}$). If the corn land were not developed, it would remain as dryland range with a grazing rating of F.

Table 6-18 shows the economic analysis of the probable "with" case beef industry for the same five dates from the present (1977) to the year 2020 AD, used in the probable "without" case analysis. The table is

TABLE 6-18

PROBABLE USE WITH THE PROJECT
ECONOMICS SCENARIO - HAT CREEK BASIN BEEF INDUSTRY

		1977 AD	1980 AD	1990 AD	2000 AD	2020 AD
a.	Cows (from model analysis)	2000	2038	2881	3081	3184
b.	Calves produced (85% a)	1700	1732	2449	2619	2706
c.	Steer calves sold (50% b)	850	866	1224	1309	1353
d.	Cow mortality (2% a)	40	41	58	62	64
e.	Cull cows sold (12% a)	240	245	346	370	382
f.	Heifer calves for replacement (d + e)	280	286	403	431	446
g.	Heifer calves sold (50% b - f)	570	581	821	878	907
h.	Value of steer calves sold (c x sale price[1])	$132 600	$169 736	$239 987	$256 647	$265 227
i.	Value of cows sold (e x sale price[1])	$ 70 800	$ 72 275	$101 987	$109,067	$112 714
j.	Value of heifer calves sold (g x sale price[1])	$ 67 260	$ 85 988	$121 521	$129 957	$134 301
k.	Total revenue (h + i + j)	$270 660	$327 999	$463 495	$495 671	$512 242
l.	Total cost ($a \times cost.cow^{-1}$, Table 5-20)	$255 020	$259 865	$367 356	$392 858	$405 992
m.	Total net revenue (k - l)	$ 15 640	$ 68 134	$ 96 139	$102 813	$106 250
n.	Net revenue.Cow^{-1} ($m \times a^{-1}$)	$8	$33	$33	$33	$33

Sale Prices[1]

	Steer Calves	Cull Cows	Heifer Calves
1977	$156	$295	$118
Other dates	$196	$295	$148

[1] 1977 is based on actual prices which happen to be on the low end of the normal price cycle. Prices for other dates are estimated to be the average price of the normal cycle based on 1977 dollars.

arranged identically to that of the scenario economics for the "without" case (Table 5-19)[2] to facilitate comparison of the various economic elements.

(v) Comparison of the Scenario Economics for the Original and Selected Project Descriptions

Table 6-19 compares the two project descriptions in terms of the number of cows and net revenue from the production and marketing of those cattle. The table exhibits that for years 1977 and 1980 no difference occurs between the two project descriptions. However, years 1990, 2000 and 2020 all exhibit a greater number of cattle and therefore an increased net revenue as a result of the selected project description. In other words, the selected project description does not have as great an impact on agricultural beef production as the original project description.

As illustrated in Table 6-19, this lowered impact is not substantial. For example, by year 2020 the net revenue difference between the two project descriptions is only $2600. Consequently, it is felt all mitigation and compensation guidelines[2] still adequately address the selected project case for agriculture.

(vi) Decommissioning

The main differences in the overall decommissioning assessment of the revised project from that previously reported[2] results from the new location and capacity of the proposed plant water supply reservoir and the unavailability of the pit rim dam as a storage reservoir in decommissioning. In addition to the

previously identified impacts, in the operation phase, the Medicine Creek reservoir is expected to have significant interference with present and probable irrigation use amounting up to 232 ha.m/a (1880 ac ft/yr). However, only 12 ha.m/a of present use is lost. There are, however, additional benefits possible during the decommissioning stage due to the new reservoir scheme, but accounting for the unavailability of pit rim dam storage, the total benefits reported are about the same magnitude in terms of water quantity.[2] However, since the storage is at a higher elevation and actual potential benefits are probably greater.

TABLE 6-19

COMPARISON OF THE PROBABLE USE WITH THE PROJECT FOR THE HAT CREEK BASIN BEEF INDUSTRY ECONOMICS SCENARIO

	Cows (from model analysis)			Total Net Revenue ($)		
Year	Original Project	Selected Project	Difference	Original Project	Selected Project	Difference
1977	2000	2000	0	15 640	15 640	0
1980	2038	2038	0	68 134	68 134	0
1990	2813	2881	+68	94 136	96 139	+2003
2000	3009	3081	+72	100 485	102 813	+2328
2020	3109	3184	+75	103 650	106 250	+2600

SECTION 7.0 - SUMMARY AND CONCLUSIONS

This bridging document represents a re-evaluation of the original Land Resources impact assessments in light of the revised engineering configuration. In addition, corrections were made to the agriculture report as a result of government comments.

7.1 PROJECT ALIENATIONS

(a) Physical Habitat and Range Vegetation

No change in the impacts to climate, landform and geology are anticipated from the construction, operation or decommissioning of the Hat Creek project.

Soil impacts exhibit a general decrease in area alienated. Soils classed as highly sensitive were also alienated to a lesser degree.

Impacts to the vegetation associations have been reduced by the new project configuration, except for the Douglas fir - pinegrass - bunchgrass and Bunchgrass - Kentucky bluegrass associations. These associations exhibit an increase in area alienated of only 0.4 and 1.5 percent for the entire Hat Creek local study area.

It can be concluded that impacts to physical habitat and range vegetation have been reduced. Original assessments[9] then represent a very conservative case. These impacts are replaced by those given in this bridging document.

7.1 PROJECT ALIENATIONS - (Cont'd)

(b) Wildlife

The expected impact to the wildlife resources should remain consistent with that previously assessed.[8] Wildlife habitats are generally alienated to a lesser degree. Increases do occur in the high capability riparian and Douglas fir - bunchgrass types. However, these increases are minor considering the extent of these types in the local study area.

Wildlife resource use remains unchanged from original assessments.[8]

(c) Forestry

The reduction in the production forest area lost due to the selected project design coupled with increased impacts from air emissions (244 m/MCS) resulted in an overall decrease in the forestry impacts. This reduction in impact results in an annual MAI loss of $8343 less than originally assessed,[1] or increased benefits of $278 000 at a 3 percent discount rate.

(d) Agriculture

The impact of the selected project design on agriculture has been reduced; however, this reduction is minimal. Project alienations from the selected project description result in an increase of 29.4 ha for open alienation, and a decrease of 860 ha for closed alienation. The overall implications are an increase in the total net revenue (beef industry) of $2600 in year 2020. No difference is evident in years 1977 or 1980.

7.2 AIR EMISSION IMPACTS

In all cases, previous impact assessments[1,2,8,9] have assessed the selected stack and cooling tower configurations (244 m/MCS

and two natural draft towers). A reassessment of these was only undertaken in order to incorporate new information as discussed in Section 5.0.

A review of these data indicated that they have no effect on the original impact assessments with respect to air emissions.[1,2,8,9] Fluorine was the only element that may have a greater impact. This was handled under the "worst case" scenario for forestry and did not require a reassessment.

Consequently, it can be assumed that previous impact assessments for air emissions remain valid when examining the 244 m/MCS and two natural draft cooling tower assessments.[1,2,8,9] Forestry and agriculture were the only two resources that utilized the assessments of air emissions in a quantitative sense. The results of these quantitative analyses were reported under Project Alienations (Section 7.1 (c) and (d)).

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APPENDIX A

CLIMATE CAPABILITY MAPPING

Comments made by government agencies required special emphasis on climate capability mapping. This required remapping most of the local study area and numerous changes to the inventory and impact assessment reports for agriculture.[2] Rather than completely revising both the agriculture inventory and impact assessment reports, the map and the pages requiring revision are presented.

The *following pages which correspond to those of the* agriculture report[2] required revision.

Inventory : Pages 2, 3, 4, 17, 18, 29, 45, 46, 65, 66, 67, 68, 108 and A-1 to A-5.

Impact : Pages 12, 13, 18, 39, 40 and 181.

All references relate to the agriculture report.[2]

A.1 HAT CREEK AGRICULTURE - CLIMATE CAPABILITY CHANGES IN INVENTORY REPORT

The following pages represent those found in the Hat Creek Agriculture report.[2] The page number at the top of the page have been retained for easy reference.

climate in the province and there are areas with poor climate for agriculture. The highest climate capability occurs at the lower elevations particularly along the benches of the Fraser and Thompson Rivers and the Nicola Lake and Kamloops Lake areas. Irrigation is required for the production of most agricultural crops in these areas.

(ii) Land Capability for Agriculture

Land capability of the Regional Study Area was broken down on the following basis: land of high agricultural capability - 12 percent; land of grazing capability - 43 percent; land of limited or no agricultural value 45 percent. The distribution of the high capability lands is largely a function of climate and occurs in the river valleys and on the plateaus of the northern part of the region. The Regional Study Area contains 30 percent of the provincial total of CLI agricultural capability class 1 land.

(iii) Agricultural Land Reserves

Within the Regional Study Area approximately 9190 km^2 (3547 mi^2) are included in the Agricultural Land Reserve (ALR) which represents 25 percent of the land area of the region and 20 percent of ALR land of the province. The majority of these lands are found adjacent to the major rivers and their tributaries and on the plateau areas north and west of Clinton.

(iv) Present Agricultural Use

The present agriculture of the Regional Study Area is primarily devoted to a cow/calf type of beef enterprise. The climate, soil and topography of the region provide the resources - productive river valleys that are well suited to forage production for winter

feed; and large tracts of grazing land that provide summer range pasture required for this type of enterprise. Beef cattle raised in the region are mainly sold as calves for finishing outside of the province.

On the basis of 1976 census statistics (Thompson-Nicola Census Division) present farmland in the area, 5476 km^2 (1,353,538 acres), represents 23 percent of the provincial total; beef cattle numbers, 135,119, represents 23 percent of provincial total; and area of forage production, 307 km^2 (75,971 acres) represents 11 percent of provincial total.

(b) Local Study Area

(i) Climate Capability for Agriculture

The Climate Capability for Agriculture Classification System was used to describe the varied climate of the Local Study Area. In general, the climate of most of the Local Study Area is restricted by aridity or lack of moisture during the growing season and irrigation is required for crop production.

Climate Classes 1b, 1a, and 1 (improved ratings which assumes irrigation) are found in the valleys and associated benches of the Thompson, Fraser and Bonaparte Rivers. There are also isolated pockets of class 1 climate found in the Hat Creek valley. The 1b and 1a classes are suitable for the production of heat-loving crops such as tomatoes and vine crops. These areas are located on the lower benches and valley bottoms of the Fraser, Thompson and Bonaparte Rivers and make up 16 percent of the Local Study Area. The class 1 climate areas, suitable for the production of a wide range of crops including corn, occur in 14 percent of the Local Study Area.

The benches adjacent to the class 1 areas generally have class 2 or 3 climates which are suitable for cool-loving vegetables like cabbage, forage crops, and most cereal grains. These two climate classes, which also occur in the Hat Creek valley make up 26 percent of the Local Study Area.

The remainder of the Local Study Area, which includes the lower and upper regions of the mountain areas, has climate capability of class 4 through 7. This area is limited to some extent by aridity but the major limitations to agricultural production are the short length of the freeze free period and the low number of accumulated growing degree days. Class 4 and 5 climate areas, which are limited to forage production or native rangeland, make up 26 percent of the Local Study Area. Class 6 and 7 climate areas, which have respectively limited or no agricultural potential, make up 16 percent of the Local Study Area.

(ii) Land Capability for Agriculture

Land within the Local Study Area with capability for irrigated agriculture (based on the Land Capability for Agriculture Classification System) is found principally in the valleys and benches of the Thompson, Bonaparte and Fraser Rivers, on the plateaus east of Pavilion and in the Hat Creek valley. This land occupies a total of 260 km^2 (100 mi^2) which represents 13.2 percent of the Local Study Area.

Land of class 1 agricultural capability,capable of producing the very widest range of vegetables, cereal grains, forages, berry fruits and numerous specialty crops,occupies 37 km^2 (14 mi^2) or 1.9 percent of the Local Study Area. Lands with agricultural capability class 2, capable of producing a wide range of crops, occupy 19 km^2 (7.3 mi^2) or 1 percent of the Local Study Area.

3.0 METHODOLOGY

3.1 INVENTORY

(a) Regional Study Area

(i) Historical Perspective

A short history of the Regional Study Area emphasizing agricultural development was prepared from the Kamloops Bulletin[2].

(ii) Climate Capability for Agriculture

The Climate Capability Classification System for Agriculture in British Columbia[3] differentiates climate according to the constraints that the climate of an area places on agricultural use. This system was the basis for assessing climatic limitations and enhancements to the agricultural resource in this study. In this system, areas of similar climate are identified in terms of the range of agricultural crops that can be grown. The better the climate capability rating the wider the range of crops suitable for a particular area.

To encompass the widest range of climates in Canada, the system contains eleven* capability classes (1d,1c,1b,1a,1,.....7). These are established on the basis of the following climate characteristics: freeze free period, growing degree days, effective growing degree days, climatic moisture deficit or surplus, and extreme winter minimum temperature. Climate capability is often designated for a land area on the basis of both unimproved conditions (dryland and/or undrained) wherein the classification is determined by the moisture

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* The national system, developed primarily for application to the prairie regions of Canada where grain farming predominates, has only seven classes.

regime limitations and improved conditions (irrigated and/or drained) wherein the classification is determined by thermal limitations. A detailed description of each class is provided in Appendix A.

Climate capability is used by the government agencies in conjunction with soil and landform characteristics to determine agricultural land capability (described in Section 3.1(a)(iii)).

Climate Capability for Agriculture maps[4] have been published for approximately 60 percent of the Regional Study Area at a scale of 1:125,000 (see Figure 3-1). A map of the area which includes the Hat Creek valley and the Cache Creek-Ashcroft area is currently available in provisional form[5]*. The information available from the published and provisional maps was used to describe the climate capability for agriculture for most of the Regional Study Area. For the area where no climate capability maps were available, 1:3,500,000 climate maps[6] of frost free days, growing degree days greater than 5°C, annual moisture deficit, May through September precipitation, and annual precipitation were consulted. These maps were compared to the available Climate Capability for Agriculture maps which allowed a qualitative assessment of the unmapped portion of the Regional Study Area. Note that the above climate parameters are similar to those on which climate capability maps are based. The relatively small-scale of this supplemental map information allowed only broad interpretations of climate capability for agriculture to be made.

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* a provisional map, now prepared for 92I/SW, was not available for use during this study.

(b) Local Study Area

(i) Climate Capability for Agriculture

Information on climate capability of the Local Study Area was based on a provisional Climate Capability for Agriculture map (Resource Analysis Branch[5]), the new climate capability classification system[3,30], and consultation with R. Williams and R. Wilson of the Resource Analysis Branch who were involved in the preparation of climate capability maps. The areal coverage of the climate capability map sheet comprising most of the Local Study Area is depicted in Figure 3-4. On the Climate Capability for Agriculture map, land is subdivided into homogeneous units according to the climate capability for agriculture classification system. The importance of this classification system is discussed in Section 3.1(a)(ii) and a description of each climate class is given in Appendix A.

A study map (1:50,000) was prepared from the provisional climate capability map identifying land units within the Local Study Area in terms of the nine climate capability classes, namely 1b, 1a, and 1 to 7, which occur in the area. The improved classification, which is more useful for interpreting potential agricultural use for an area where arable agriculture is dependent on irrigation, as well as the unimproved class ratings were noted. The area of each improved capability class was measured and tabulated.

Two other provisional maps depicting the climate moisture deficit and/or surplus[31], and the May through September precipitation[32] of the Local Study Area were consulted to supplement the climate capability for agriculture information with respect to climate characteristics that constrain or limit agriculture in the Local Study Area.

from a dam constructed eighteen miles upstream on Deadman River. The project was abandoned following the First World War but the remains of the flume system can still be seen from Highway 1 between Cache Creek and Savona.

During the late 1940's and 1950's the area produced potatoes and tomatoes on a commercial scale. However, due to the difficulty in obtaining the extensive labour needed for these crops, commercial vegetable production almost disappeared and alfalfa hay, a low labour crop, became predominant. Alfalfa hay was needed to support beef cattle ranching, which became the main agricultural activity of the area.

(b) Climate Capability for Agriculture

The climate of British Columbia varies widely from region to region reflecting physiography and proximity to the Pacific Ocean and to the interior of the continent. Within a particular region there can be considerable climatic variation as a result of differences in elevation and/or other climatic influencing characteristics. The Climate Capability for Agriculture classification system, outlined in Section 3.1(2)(ii), currently evaluates capability on the basis of the various climatic parameters; subsequently, an association can be made between the class rating and the potential crops that could be successfully cultivated in an area. In mapping the capability, land is divided into areas of similar climate (classes) thereby indicating the range of potential crops. The ratings range from class 1d to class 7 with class 1d representing the highest agricultural capability and class 7 having no significant agricultural capability.

Climate Capability for Agriculture maps are available for approximately three-quarters of the Regional Study Area; limited climate information is available for the remaining portion. The capability maps are available for the following land areas: Merritt-Nicola Valley, Kamloops-Kamloops Lake, Bonaparte Lake, Clinton-Green Lake,

100 Mile House, and Lillooet-Cache Creek[4,5]. An examination of these maps indicated that the highest climate capability classes occur at lower elevations particularly along the benches of the Fraser and Thompson Rivers and the Nicola Lake and the Kamloops Lake areas. These areas have been designated climatic capability classes 1b, 1a, 1, 2, and 3 under irrigated farming and classes 5 and 6 under dryland farming conditions due to limitations of drought or aridity. Dryland farming would be limited to drought resistant forage and cereal crops. Under irrigation, the limitation due to aridity is overcome and a wide range of crops could be raised. The areas with highest capability, 1b, have climatic conditions conducive for special heat-loving crops such as tomatoes and vine crops as well as hardy varieties of apples. Areas of this class climate exist on the eastern benches of the Fraser River between Lillooet and Lytton and on the benches of the Thompson River between Ashcroft and Savona. Lands that are higher in elevation than the benches have lower capability climates due primarily to a more limited freeze free period. These areas have considerable agricultural value, however, due to their forage production capability which is enhanced by the high number of growing degree days associated with the region.

To assess the agricultural climate capability of the area for which published information was not available, small scale climate maps[6] of climate parameters similar to those used by government agencies for the assessment of agricultural climate capability were consulted (Figure 4-1). An examination of these maps indicates that the remaining benches and lowlands of the Thompson and Fraser Rivers and the Lower Nicola River would have climate capability classes similar to the higher classes found in the mapped portion of the Regional Study Area because of the similarity in frost free period, growing degree days and precipitation.

4.2 LOCAL STUDY AREA

(a) Climate Capability for Agriculture

The climate capability for agriculture of the Local Study Area is depicted on Figure 4-6 (foldout). The climate classes are identified on the basis of both the unimproved class rating and the improved rating along with the limiting subclass for each rating which identifies the major characteristic(s) suppressing the agricultural capability (refer to Appendix A for a complete description of classes and subclasses).

The degree of aridity in terms of average moisture deficit during the growing season (May to September) ranges from 200 to 450 mm (7.9 to 17.7 in) in areas with class 1 or better climate capability. For the remainder of the Local Study Area, the net moisture ranges from a deficit of 200 mm (7.9 in) to a surplus of 50 mm (2.0 in) with the surplus occurring in only isolated areas of high elevation. The associated average amount of precipitation during the growing season in the Hat Creek valley lowlands is somewhat higher, ranging from 150 to 200 mm (5.9 to 7.9 in). The maximum average precipitation in the Local Study Area (May to September) occurs at the higher elevations and ranges up to more than 250 mm (9.8 in).

Class 1b and 1a climates (improved rating) are found in the valley bottoms and lower benches of the Thompson, Fraser and Bonaparte Rivers (Figure 4-6). The highest potential of these lands includes the production of special heat-loving crops such as tomatoes and vine crops. The important climatic characteristics are the relatively long freeze free period, being greater than 120 days; the high number of growing degree days greater than 5°C, being between 1505 and 2059. Another important feature of some of this area is the

subclass limitation of winter extreme minimum temperatures that are relatively severe and effectively limit the production of tree fruits, even that of hardy apples.

Areas with class 1 climate capabiltiy (improved rating) are generally adjacent to and of slightly higher elevation than those lands with higher capability. Isolated pockets of class 1 climate occur in the Hat Creek valley. Compared to classes 1b and 1a, the class 1 climate capability area has relatively short freeze free period, of 90 to 119 days and small number of growing degree days greater than 5°C, this being 1310 to 1504. Corn is the key crop designated for this climate capability class, though class 1 is suitable for a wide range of vegetables and small fruits, forage crops and cereal grains.

The benches adjacent to the class 1 areas (Figure 4-6) generally have climatic capability ratings (improved) of class 2 or 3.. These classes also occur in the Hat Creek valley where they are largely associated with the lower grasslands and have the capability for intensive agriculture where soils are not limiting. The climate characteristics that limit agricultural production are primarily the freeze free period which ranges from 60 to 89 days and the range of growing degree days greater than 5°C of 1030 to 1309. These two climate classes are suitable for cool-loving vegetables like cabbage, forage crops, and most cereal grains.

Without irrigation (unimproved conditions) the otherwise high climate capability lands described above have climate capability ratings that range from class 3 through to class 7. Aridity during the growing season is the limiting subclass designation.

The remainder of the Local Study Area (Figure 4-6), which includes the lower and upper regions of the mountain areas, has climatic capabilities that range from class 4 through class 7. This area

is limited to some extent by aridity but the major limitations to agricultural productivity are the short length of the freeze free period, this being less than 60 days, and the low number of growing degree days greater than 5°C, this being less than 1169. The lower mountain regions have generally class 4 and 5 climates which limit their value for cultivated agriculture to the production of forage crops (class 4) but allows considerable grazing potential. Areas with class 6 and class 7 climate capabilities have respectively limited or no agricultural potential and are largely associated with the higher elevation mountains in the western portion of the study area.

The area of each climate capability class (improved rating) in the Local Study Area is shown in Table 4-9. The areas of class 1b, 1a, and 1 climate encompass 598 km² (231 mi²) which represents 30 percent of the study area. Within this area, 320 km² (124 mi²) is designated as class 1b and 1a which represents about 16 percent of the Local Study Area. Climate classes 2 and 3 represent over 510 km² (197 mi²) or 26 percent of the Local Study Area. The areas of class 4 and 5 climate capability lands account for 500 km² (193 mi²) or 26 percent of the Local Study Area. The areas of classes 6 and 7 climatic capability comprise 318 km² (123 mi²) which is 16 percent of the study area.

(b) Land Capability for Agriculture

(i) *Land Capability for Irrigated Agriculture*

The capability of lands within the Local Study Area for irrigated agriculture is shown in Figure 4-7 (foldout). These lands are

TABLE 4-9

CLIMATE CAPABILITY FOR AGRICULTURE
LOCAL STUDY AREA

Climate Capability Class*	Area (km^2)	Percentage of Local Study Area
1b	97	5
1a	223	11
1	278	14
2	266	14
3	244	12
4	155	8
5	345	18
6	181	9
7	137	7
Unclassified**	37	2
	1,963	100

* Irrigated rating.

** Reliable information not available.

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CLIMATIC CAPABILITY CLASSES [3]

For Climatic Classes 1d, 1c, 1b and 1a, full capability can only be achieved if supplemental water is applied.

Climatic Class 1d

Limitations:

The freeze free period is greater than 150 days. Growing degree days accumulated above 5°C are greater than 2225.

Range of Crops:

Examples are apricots, peaches, cherries, pears, plums, apples, strawberries, raspberries, grapes, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains, forage crops, tulips, daffodils and other bulb crops where no supplemental water is necessary.

Climatic Class 1c

Limitations:

The freeze free period is greater than 150 days. The range of growing degree days accumulated above 5°C is 2060 to 2225.

Range of Crops:

Examples are apricots, peaches, cherries, pears, plums, apples, strawberries, raspberries, grapes, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1b

Limitations:

The freeze free period is greater than 150 days. The range of growing degree days accumulated above 5°C is 1780 to 2059.

Range of Crops:

Examples are hardy apples, strawberries, raspberries, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1a

Limitations:

The freeze free period is 120 to 150 days. The range of growing degree days accumulated above 5°C is 1505 to 1779.

Range of Crops:

Examples are hardy apples, strawberries, raspberries, beans, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1

Limitations:

The freeze free period is 90 to 119 days in the interior areas of the province and greater than 150 days in coastal areas. The range of growing degree days above 5°C is 1310 to 1504 for the interior areas. For the coastal areas effective growing degree days above 5°C are greater than 825. There is a climatic moisture deficit of up to 40 mm (1.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio less than 0.33.

Range of Crops:

Examples are tree fruits*, strawberries, raspberries, beans, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, bulbs, filberts, cereal grains and forage crops.

Climatic Class 2

Limitations:

The freeze free period is 75 to 89 days in the interior areas and 120 to 150 days in coastal areas. The range of growing degree days above 5°C is 1170 to 1309 for the interior areas. The range of effective growing degree days for the coastal areas is from 736 to 825. There is a climatic moisture deficit of 40 to 115 mm (1.5 to 4.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.34 and 0.55.

Range of Crops:

Examples are strawberries, raspberries, asparagus, lettuce, potatoes, carrots, beets, radishes, peas, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 3

Limitations:

The freeze free period is 60 to 74 days in the interior of the province and 100 to 119 days in the coastal areas. The range of growing degree days above 5°C is 1030 to 1169 for the interior areas. The range of effective growing degree days above 5°C is from 650 to 735. There is a climatic moisture deficit of 116 to 190 mm (4.6 to 7.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.56 and 0.75.

Range of Crops:

Examples are strawberries, raspberries, potatoes, lettuce, peas, spinach, cauliflower, cabbage, cereal grains and forage crops.

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*Tree fruits can be grown in some areas such as the Saanich Peninsula where there is no climatic moisture surplus.

Climatic Class 4

Limitations:

The freeze free period is 50 to 59 days in the interior areas of the province and 80 to 99 days in coastal areas. The range of growing degree days above 5°C is 1030 to 1169 for the interior areas. The range of effective growing degree days for the coastal areas is 491 to 649. There is a climatic moisture deficit of 191 to 265 mm (7.5 to 10.4 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.76 and 1.00.

Range of Crops:

Examples are hardy varieties of cool season loving vegetables (lettuce, peas, spinach, cabbage), forage crops, and periodically cereal crops are capable of being grown.

Climatic Class 5

Limitations:

The freeze free period is 30 to 49 days in the interior areas of the province and 60 to 79 days in coastal areas. The range of growing degree days above 5°C is 780 to 1029 for the interior areas. The range of effective growing degree days above 5°C for the coastal areas is 421 to 490. There is a climatic moisture deficit of 266 to 340 mm (10.5 to 13.4 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio greater than 1.00.

Range of Crops:

Only forage crops are produced.

Climatic Class 6

Limitations:

The freeze free period is less than 30 days in the interior areas of the province and 40 to 59 days in coastal areas. The range of growing degree days above 5°C is 670 to 779 for the interior areas. The range of effective growing degree days above 5°C for the coastal areas is from 245 to 420. There is a climatic moisture deficit of 341 to 415 mm (13.4 to 16.3 inches) during the growing season.

Range of Crops:

The area is limited to native browse (grazing) species of plants.

Climatic Class 7

Limitations:

The freeze free period is highly variable and less than 30 days in the interior areas of the province and less than 40 days in coastal areas. The number of growing degree days above 5°C is less than 670 for the interior areas. There are less than 245 effective growing degree days for coastal areas. There is a climatic moisture deficit of greater than 415 mm. (16.3 inches).

Range of Crops:

There is no potential for agriculture.

SUBCLASSES

A capability class is designated by a number, sometimes followed by a small letter, such that Class 1d has the highest capability and Class 7 has the lowest capability. With the exception of Class 1d for the interior areas of the province and Class 1 for the coastal areas, the capability classes are influenced by thermal and/or moisture limitations. The degree of the limitation(s) determines the capability class while the nature of the limitation(s) indicates which thermal and/or moisture characteristics are suppressing the agricultural capabilities.

The following subclasses denote the climatic limitations which adversely affect the capability of the land to support agriculture.

SUBCLASS A - Drought or aridity occurring between May 1st and September 30th resulting in moisture deficits will limit plant growth. The climatic moisture deficit criterion is being used for this limitation.

SUBCLASS F - Minimum temperature near freezing will adversely affect plant growth during the growing season. In this classification the Freeze Free Period (FFP) of $0^{o}C$ is being used.

SUBCLASS G - Insufficient heat units (Growing Degree Day or Effective Growing Degree Day) during the growing season.

SUBCLASS E - Extreme minimum temperatures occurring during the winter season will injure or kill dormant or near dormant fruit trees. Either cropping history or minimum temperature of less than $-35^{o}C$ can be used as the indicator of this subclass.

SUBCLASS Y - Excess precipitation between May 1st and September 30th will cause flooding, poor trafficability and generally poor yield and harvest conditions. The ratio of the climatic moisture surplus and Potential Evapotranspiration is being used as the criterion for this limitation.

EXPLANATION OF MAP SYMBOLS

The Climatic Capability for Agriculture maps have two ratings (symbols) per unit. The first symbol indicates that capability class as determined by the moisture regime limitations while the second symbol, shown in brackets on the map, indicates that class as determined by thermal limitations. The improved capability rating (lands being irrigated or drained) is synonymous with the class representing the thermal limitations since it is assumed that the moisture limitations are eliminated. The unimproved ratings (dry-land or undrained) is determined by the most severe limitation imposed by the moisture and/or the thermal criteria.

EXAMPLE I.

$\overset{4A}{(3GF)}$ 4A represents the moisture rating and 3GF the thermal rating. This dual symbol indicates an unimproved (dry-land) capability rating of Class 4 with a limitation due to a lack of moisture (A). The improved (irrigated) capability rating is Class 3 with limitations due to an insufficient accumulation of heat units (G) and to reduced freeze free period (F).

EXAMPLE II.

$\overset{3A}{(3GF)}$ indicates an area where the unimproved (dry-land) capability rating is Class 3 with limitations due to lack of moisture (A), insufficient accumulations of heat units (G) and reduced freeze free period (F). Irrigation will not improve the capability rating of this land unit as the thermal characteristics continue to apply a Class 3 limitation.

EXAMPLE III.

$\overset{3A}{(4G)}$ indicates an area with both unimproved and improved ratings of 4G since the thermal limitation is more severe than class 3A. However, irrigation will improve the moisture regime.

EXAMPLE IV.

$\overset{4A}{(3GF^{7} - 4F^{3})}$ this characterizes a complex unit with an improved (irrigated) capability of Class 3 for 70% of the area, with limitations due to insufficient accumulations of heat units (G), and reduced freeze free period (F) and Class 4 for 30% of the area with a limitation due to reduced freeze free period (F). Because the moisture regime limitation indicates a Class 4 capability, the unimproved (dry-land) capability of this complex unit is Class 4 for 70% of the area with limitation due to insufficient moisture (A) and Class 4 for 30% of the unit with limitations due to insufficient moisture (A) and reduced freeze free period (F). Complex units usually occur where the data, mapping procedures, or mapping scale do not allow the further subdivision of a unit of land.

On the Climatic Capability for Agriculture maps, the isolines delineate units of different moisture-limited and thermally-limited classes

A.2 HAT CREEK AGRICULTURE - CLIMATE CAPABILITY CHANGES IN THE IMPACT ASSESSMENT

The following pages represent those found in the Hat Creek Agriculture Impact Assessment report.[2]

Beef Industry

The future role of the beef industry within the Regional Study Area was qualitatively projected on the basis of analysis of industry trends and expectations of regional feed production.

Cash Crop Industry

The future role of the cash crop industry (vegetables and fruits) within the Regional Study Area was qualitatively projected on the basis of analysis of market demand trends and climate capability.

(ii) Local Study Area

A. Potential Agricultural Use

Irrigable Land

The potential crop production on irrigable lands within the Local Study Area was determined from Canada Land Inventory (CLI) agricultural capability information (see page 67, Vol. I), climate capability information (see page 65, Vol. I) and crop yield information.

Representative crop types were assigned to the potentially irrigable lands (CLI agricultural capability classes 1 - 5, see Figure 4-7, foldout, Vol. I). Each combination of CLI agricultural capability class and climate capability class represent a suitability for certain crops as set forth in the B.C. government publication *Climate Capability Classification for Agriculture*[3]. Areas with climate capability class 1b or 1a and CLI agricultural capability 1, 2, or 3 are suitable for the production of a very wide range of crops,

including heat-loving crops such as tomatoes and vine vegetables. A tomato crop was assigned to all areas in this category for the potential use analysis. Areas with climate capability class 1 and CLI agricultural capability 1, 2, or 3 are suitable for the production of a wide range of crops, including corn and potatoes. A corn crop was assigned to all areas in this category. Areas with climate capability class 2 and CLI agricultural capability class of 2 or 3 are suitable for production of short season vegetables such as cabbage, lettuce, and cauliflower. A cabbage crop was assigned to all areas in this category. Areas with climate capability class 3 and CLI agricultural capability class 3 are suitable for the same crops as the previous category but with a reduced productivity. Cabbage was also assigned to this category. Areas with climate capability classes 1b, 1a, 1, 2, 3, or 4 and CLI agricultural capability class 4 are suited, primarily, to the production of forage crops like alfalfa and mixed grass hay. A hay crop type was assigned to all areas in this category. Areas with CLI agricultural capability class 5 are suited primarily to the production of irrigated pasture and this was the crop type assigned to these areas.

The land within the Local Study Area with the potential for the production of each of the above assigned crop types was measured for area.

Average crop yields[25,26,27] of the Local Study Area for the assigned crops (corn, tomatoes, cabbages, hay, and irrigated pasture) were used in conjunction with the potential area of each crop to provide an estimate of the total production potential of irrigable crops within the Local Study Area.

basis of climate restrictions as represented by the Climate Capability for Agriculture map (Figure 4-6, foldout, Vol. I) and the soil and topographic characteristics considered above. These crops, in most cases, are not the only ones that could be grown. They represent the higher value crops that are suited to the different types of irrigable land.

The soil units that were mapped by the provincial soil survey[48] (Thompson River benches in vicinity of Cache Creek) had been rated for suitability for irrigation as part of that survey. Each soil unit was designated an irrigation class (not agricultural capability class) which was based on soil characteristics of depth, texture, stone content, topography, alkalinity and salt content. The irrigation class was used to identify the irrigable lands as well as the crop types for this area. Soil units with an irrigation class 1 or 2 were judged to be suitable for tomato, corn, or cabbage production with the determining factor between them being climate as described by the Climate Capability for Agriculture map (Figure 4-6, foldout, Vol. I). Climate capability class 1b or 1a indicates a suitability for tomatoes; class 1 indicates a suitability for corn; and climate capability class 2 or 3 indicates suitability for cabbage. Soil units with irrigation class 3 or 4 were judged suitable for hay production, except for certain irrigation class 3 soils where stoniness was not a major restriction thereby indicating a suitability for cabbage. Soil units with irrigation class 5 were judged suitable for irrigated pasture.

Potential crop yields for each irrigable land unit were based on reported information[25,26,27] and on professional judgement concerning specific site conditions.

TABLE 5-1

POTENTIAL IRRIGABLE LAND PRODUCTION
LOCAL STUDY AREA AND HAT CREEK BASIN

Capability Class Combination		Preferred Crop Type	Potential Productivity		Potential Area (km^2)		Potential Annual Production (10^3 Mg)	
CLI*	Climate**		$Mg\text{-}km^{-2}$	(tons-$acre^{-1}$)	LSA	HCB	LSA	HCB
1, 2 or 3	1b/1a	Tomatoes	3362	(15)	76.4	0	257	0
1, 2 or 3	1	Corn (Silage)	5604 - 6725	(25 - 30)	30.5	9.1	188***	56***
2 or 3	2	Cabbage	2242	(10)	13.2	2.0	30	4
3	3	Cabbage	1793	(8)	2.5	0	4	0
4	1b-4	Hay	1121 - 1793	(5 - 8)	79.2	33.5	115***	38****
5	1b-5	Pasture	0.2-0.3 $ha\text{-}AUM^{-1}$	(0.5-0.8 $acres\text{-}AUM^{-1}$)	58.2	23.4	23,280*** AUMs	9360*** AUMs
				Total	260.0	68.0		

* Canada Land Inventory (CLI) agricultural capability classification.

** Climate Capability for Agriculture classification.

*** Based on the average of potential productivities given.

**** Based on potential productivity of 5 $tons\text{-}acre^{-1}$.

LSA Local Study Area

HCB Hat Creek Basin

Field tomatoes were selected as the preferred crop for the areas with CLI agricultural capabilities of classes 1, 2, or 3 and a class 1b or 1a climate capability because they require the high number of growing degree days, long growing period and favourable soil conditions associated with these areas. The potential production of tomatoes in the Local Study Area is 257,000 Mg (283,294 tons) which is extremely high considering that the total provincial production of field tomatoes in 1976 was 900 Mg (992 tons)[76]. The total present provincial production of all heat-loving crops (tomatoes, cucumbers, melons, etc.) would probably not exceed 2000 Mg (2205 tons).

Silage corn was selected as the preferred crop for the areas with CLI agricultural capabilities of classes 1, 2, or 3 that have a class 1 climate capability (silage corn can also be grown to advantage in the class 1b and 1a climate areas). The potential production of silage corn is 188,000 Mg (207,235 tons) in the Local Study Area including 56,000 Mg (61,729 tons) in the Hat Creek basin. At the present time there is a relatively small amount of silage corn grown in the Local Study Area; in the province, annual production in 1976 was 317,500 Mg (349,983 tons)[76].

Cabbage was selected as the preferred crop type for those areas with a CLI agricultural capability class of 2 or 3 and climatic capability of class 2. Production is projected at 30,000 Mg (33,069 tons) for the Local Study Area with 4000 Mg (4409 tons) being produced in the Hat Creek basin. The provincial production of cabbage in 1976 was 5600 Mg (6173 tons)[76]. Areas of CLI class 3 agricultural capability with a class 3 climate have a potential for production of a restricted range of short season vegetables. This range would include cabbage but with a lower productivity compared to the previous example. Potential production of cabbage for these areas is estimated at 4000 Mg (4409 tons).

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86. Rimberg, David. 1975. Utilization of Waste Heat from Power Plants, Pollution Technology Review No. 14, Energy Technology Review No. 3, Noyes Date Corporation.

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89. Cane, D. May 1978. Heat Pumps for Residential Heating, Canadian Building Digest 195.

90. Pile, Robert S., Burns, Earl R., & Madewell, E., Division of Agricultural Development, Tennessee Valley Authority. An Operational Greenhouse Utilizing Reject Heat for Environmental Control - Paper No. 76-4548 presented to American Society of Agricultural Engineers, 1976 Winter Meeting in Chicago, Illonois, December 14-17, 1976.

91. Hirst, E. 1973. Journal of Environmental Quality, 2:166-171, Environmental Control in Animal Shelters using Power Plant Effluent.

92. Mandell, D.A., Department of Mechanical Engineering, City of Seattle. July 1974. Thermal Power Plant Waste Heat Utilization.

93. B.C. Department of Agriculture. November 1972. Climate Capability Classification For Agriculture. British Columbia Land Inventory (CLI) Climatology Report Number 1, 2nd Edition.

A.3 REVISED CLIMATE CAPABILITY MAPS

Maps 4-6a and 4-6b (see map pocket) are the revised climate capability maps for agriculture. The figure number relate to those in the agriculture report.[2]

APPENDIX B

PROBABLE AGRICULTURE USE MAP

The following map (Fig. B1-1, in map pocket) was produced to complete the mapping of the site specific study area.

The same basic methodology was used to prepare it except for some minor deviations. The information used and method are outlined below.

B.1 BASE MAPS USED

1. Present agriculture use (Fig. 4-11b, 1:24 000, CBRE)[2] - which provided delineation of present irrigated land and deeded and leased land by farm unit.

2. Potential agriculture use (Fig. 5-1b, 1:24 000, CBRE)[2] - which provided the delineation of potentially irrigable land in terms of preferred crop type and for nonirrigable land, the rangeland category.

A major update of this figure was undertaken in order that information be expanded to cover the entire map sheet. For rangeland, this involved the transfer of vegetation map information (Fig. 4-6, 1:50 000, TERA);[8] for irrigable land this involved the transfer of BCMA soils information (ref. 48, Agriculture Report)[2] superimposed with climate capability information (Fig. 4-6 as revised by TERA) to determine preferred crop. The rangeland information was expanded in the northern one-third of the map and in a small area near the south of the sheet; the irrigable lands information was expanded in the lowland areas east, north and to about 3000 m south of Cache Creek and in an area at the south end of the map sheet.

B.2 ASSIGNMENT OF PROBABLE USE

In general it was felt that the ability to provide for future irrigation of presently nonirrigated lands located on the benches in the vicinity of Cache Creek and Ashcroft is not limited by water availability nearly to the extent that it is in the Hat Creek valley. Though not rigorously analyzed, it appears that the Bonaparte and Thompson rivers offer potential sources of water for some individual as well as regional irrigation systems. The favorable agricultural climate of the area provides impetus for irrigation development.

The following criteria were used in assigning irrigated land for probable use:

1. Inclusion of all presently irrigated land (in a few instances, these lands, according to soil survey information, are not potentially irrigable, however, since they are being irrigated, they were assigned a preferred crop type of 5 (irrigated pasture).

2. Inclusion of all irrigable lands having a preferred crop of 1-4, except small isolated areas.

3. Inclusion of irrigable land of preferred crop 5 where adjacent to better lands (1-4s).

4. Exclusion of irrigable land within townsites.

5. Exclusion of land of greater than 20 percent slope.

6. Exclusion of lands above 610 m elevation, except those near Cornwall Creek to which upland flow might be expected to be diverted. Though arbitrary, it was felt that lifts to lands above 610 m would be somewhat excessive.

APPENDIX C

VERIFICATION OF WATER USE

CONTENTS

TABLES

APPENDIX C

VERIFICATION OF WATER USE

C.1 INTRODUCTION

The following information was produced to verify certain impacts of the project on water use. The following areas have been addressed:

1. The fate of the corn land to the northeast of the open pit: Could it be used in small parcels or should it be assumed to be totally alienated?

2. The allocation of irrigated land: Is it based on farm units or irrigation water availability, and if the former, could the water be reassigned?

3. Check on the agricultural present use maps[2]: The lands presently irrigated especially in the valley bottom and upper Medicine Creek need to be confirmed.

4. The quantity of water available for irrigation in the area of the development needs to be verified - original estimates may be high since the quantity originally used was based on run-off quantities as measured at the mouth of Hat Creek.

5. Provide a more reasonable discussion of the "probable" case. Clearly identify the Storage Structures required for practical application of this case.

C.2 DISCUSSION

Each of the five areas mentioned in Section C.1 will be discussed separately. Many of the following points were analyzed by Canadian Bio Resources Engineering, Ltd.[22]

1. The fate of the corn land to the northeast of the open pit. Could it be used in small parcels or should it be assumed to be totally alienated?

   The land in upper Hat Creek mapped as "probable" corn land not directly alienated by the selected project design could be farmed in parcels bounded by the project activities. This land was mapped as having the potential to grow corn based on climate and soil constraints. In addition, several conditions would also have to be met:

   a. That corn trials support the analysis of base resources which projects corn suitability,

   b. that satisfactory arrangements can be made between B.C. Hydro and farm operator(s) for the intensive agricultural use of this land, and

   c. that irrigation water can be economically supplied to these lands.

   The availability of irrigation water is a major constraint since Beak[23] have shown the water sources of upper Hat Creek to be fully committed except for a short period during spring run-off. Consequently, water to develop this land would have to be supplied by some other means, e.g. storage. The fact that corn trials would have to be conducted is also an important consideration to future corn development on these lands.

C.2 DISCUSSION - (Cont'd)

Fig. C-1 depicts the seven parcels of potential corn land that are thought to be developable with the selected project design. They total approximately 143 ha and vary in size from 6 ha to about 56 ha.

There are a number of factors which are considered to be of positive impetus to the development of this land for intensive agriculture *with the project*. Firstly, the fact that the land is controlled by a single owner (B.C. Hydro) may facilitiate development planning and eventual use over that which may have occurred otherwise (it must be remembered, however, that 169 ha (417.6 acres) of corn land is totally alienated by the project, thus reducing the amount of land potentially developable between the without and with project cases). Secondly, project roads could provide ready access to all parcels identified. Thirdly, development of a gravity irrigation supply system for these lands could be incorporated into the design of the plant make-up reservoir and outlet conduit for use upon decommissioning.

2. The allocation of irrigated land: Is it based on farm units or irrigation water availability and if the former could the water be reassigned?

The allocation of irrigated land was done using soils, climate capability and water availability information. As Beak[23] have shown, water is fully committed except for a 6-week period during the spring freshet. This water was allocated to spring pasture in the agricultural probable use case. Consequently this water is available and presently unlicensed.

Reassignment of water outside a farm unit if the unit is alienated is theoretically possible. This would be subject to provincial approval. This is especially true of presently unlicensed water (spring) allocated in the probable use agriculture case.

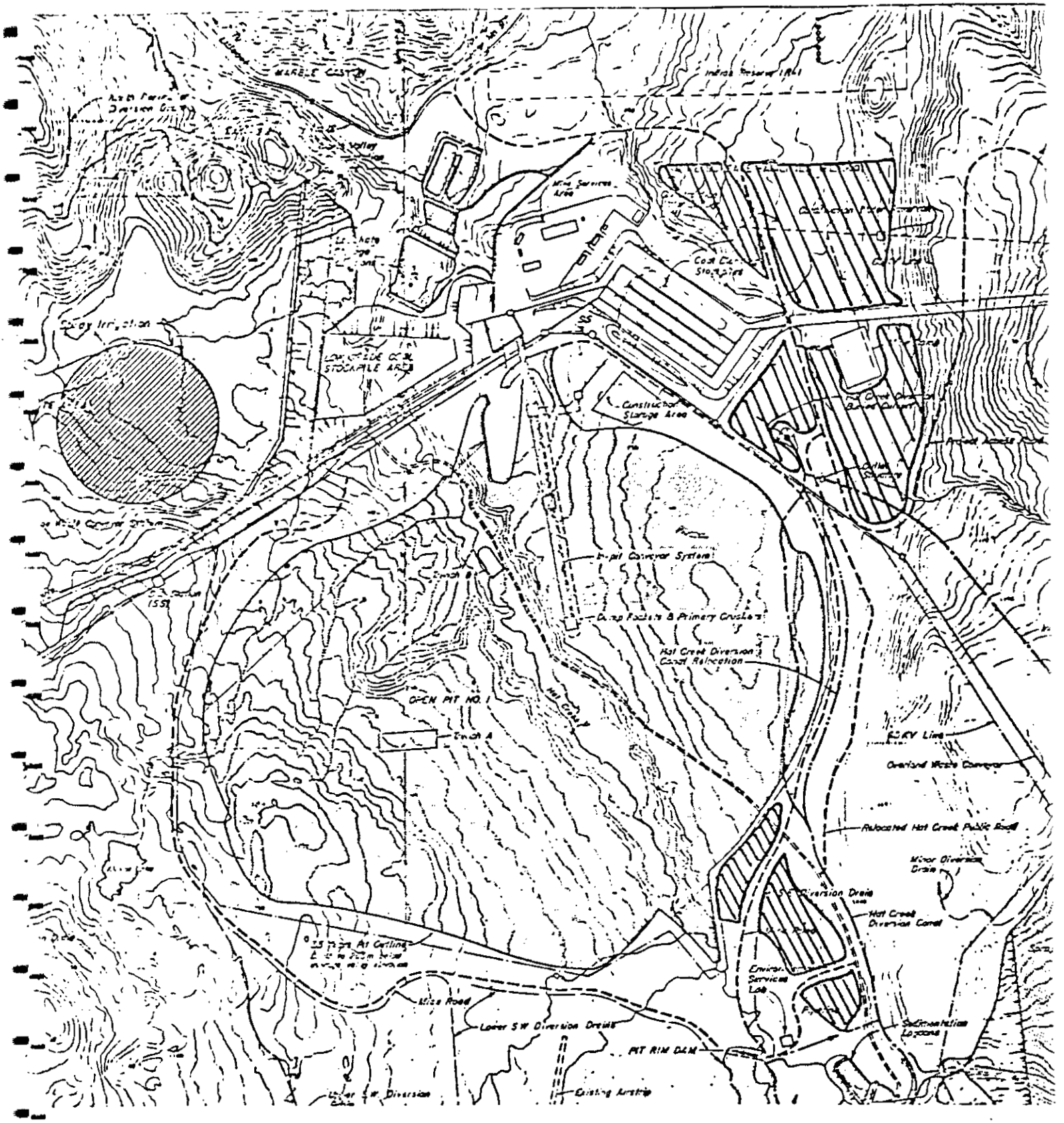


Fig. C-1 - Parcels of Potential Corn Land

C.2 DISCUSSION - (Cont'd)

3. Check on the present use maps[2] - the lands presently irrigated especially in the valley bottom and upper Medicine Creek need to be confirmed.

   Two areas within the site specific study area have been questioned as being irrigated (Fig. C-2 and C-3). Aerial photograph interpretation indicated that these areas were irrigated. However, field investigation in October 1979 showed these areas not to be irrigated. These areas receive seepage water, increasing their productivity and giving them a green tone. The relatively lush growth in these areas, irrespective of irrigation method, would be indicative of higher productivity than that associated with dryland ranges.

4. The quantity of water available for irrigation in the area of the development needs to be verified - original estimates may be high since the quantity originally used was based on run-off quantities as measured at the mouth of Hat Creek.

   By definition, probable irrigated land is directly related to the amount of water available for this purpose as water availability is a major constraint in allocating probable use in Hat Creek valley.

   In order to support the above statement and indicate the impact of the project on water use, the following water balance has been done for both upper Hat Creek and the entire Hat Creek basin (Table C-1).

   Table C-1 shows that without the project, 962 $ha.m.a^{-1}$ are available at the project site. At Carquille, 1285 $ha.m.a.^{-1}$ are available. This takes into consideration the fisheries requirement and the water needed to develop the probable spring pasture and storage for corn in upper Hat Creek valley. This water is

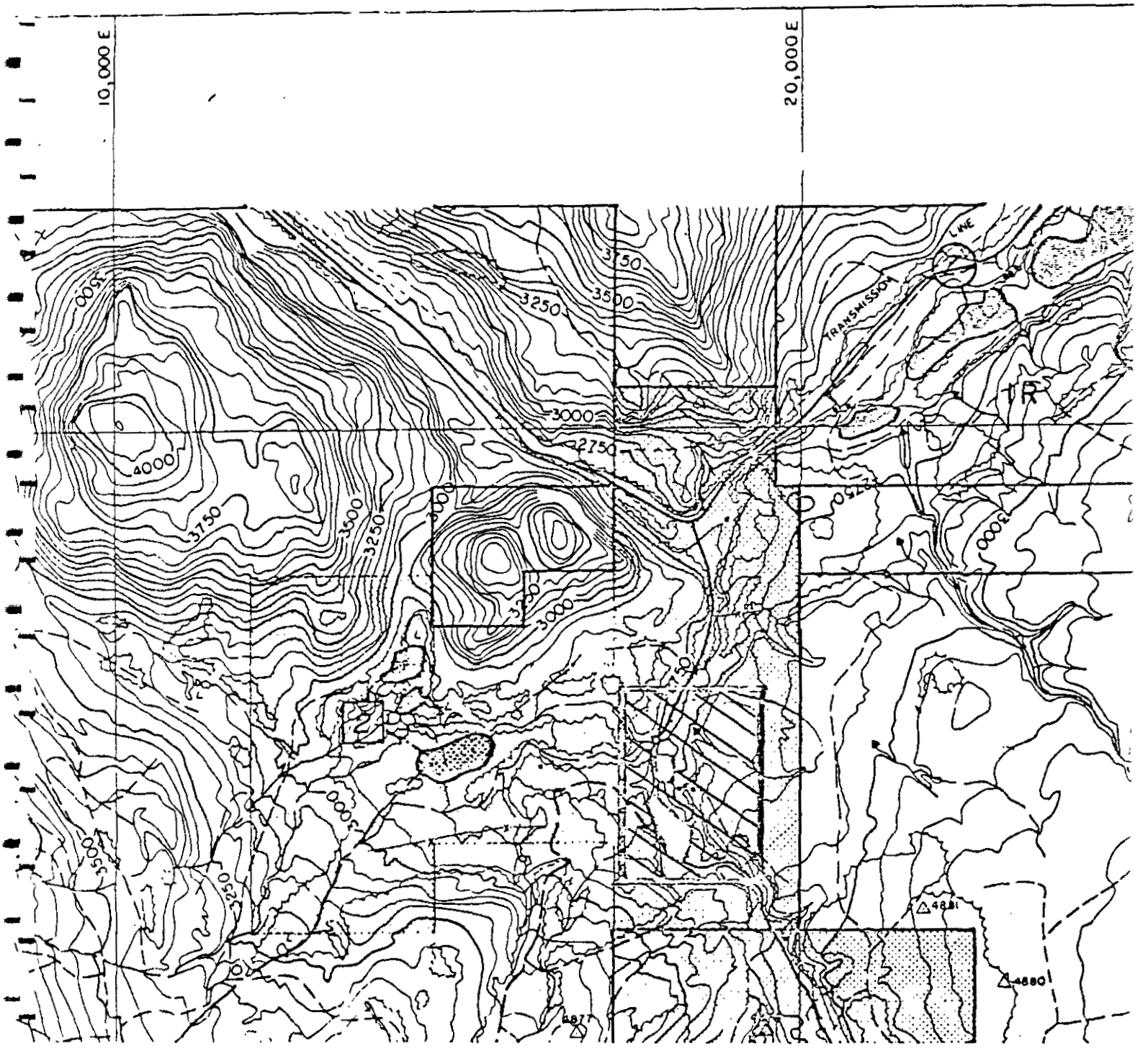


Fig. C-2 - Location of Mis-identified Irrigated Land
(portion of Fig. 4-11a[1])

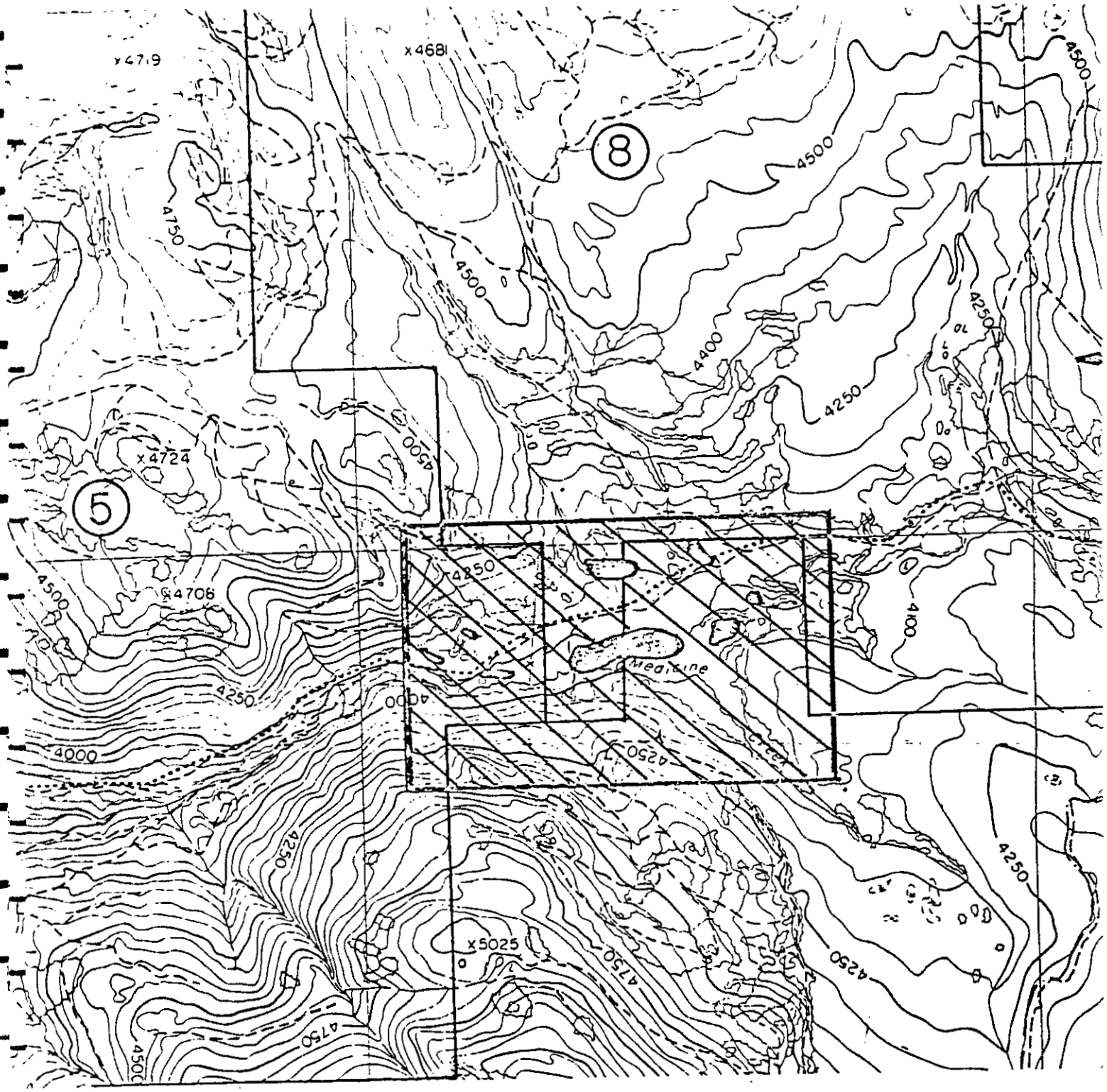


Fig. C-3 - Location of Mis-identified Irrigated Land
(portion of Fig. 4-11b[1])

TABLE C-1

SIMPLIFIED WATER BALANCE FOR THE HAT CREEK PROJECT BASED ON WATER USE
($ha.m.a^{-1}$)

Location	Without the Project				With the Project			
	Present Run-off	Fisheries[1] Requirements	Probable Use[2] Case - Projected use for Future Development	Net Available Downstream	Impact[3] (Loss of Irrigated Land)	Impact[4] (Loss of Water)	Consumptive Use by the Project[5]	Net Available Downstream
Upper Hat Creek (above gauging St. 08LF061)	2100	911	227	962	130	242	36	814
Hat Creek at Carquille (above gauging St. 08LF015)	2500	911	304	1285	130	242	36	1137

1 Information from BEAK, Inventory Report.[23]

2 Value includes additional water necessary for development of spring pasture and corn land. Present irrigation uses are not included in this figure since the present measured run-off reflects existing uses.

3 Value represents water use alienated by project facilities. This water would not be lost since it is available for reassignment.

4 Actual water lost due to the loss of Medicine Creek flows by the Medicine Creek waste dump.

5 Information from BEAK, Assessment Report.[24]

only available in the October-April and May-July irrigation periods. If the development of these probable use lands was not considered, then an additional 227 and 304 ha.m would be available at upper Hat Creek and Carquille respectively.

The with the project case causes a net reduction in the net downstream flow. This is caused by the loss of an estimated 242 ha.m of water from Medicine Creek which would be retained for use in the powerplant.

As well as the impact on present irrigation use, project use of Medicine Creek water could hinder the more economic development of the potential corn land.

However, the alienation of probable irrigated land amounts to 44 ha of all-season pasture, 37.4 ha of spring pasture and 169 ha of corn land with an associated water use of 130 ha.m. This quantity is made up as follows: 95 ha.m of this total is storage irrigation for the potential corn land. The remaining impact (35 h.m) is divided between all-season irrigation (29 ha.m) and spring pasture (6 ha.m). Although the land would be alienated by the project, all this water would remain available for reassignment as shown in Table C-1. Thus in calculating the net water availability with the project, the above impact was considered a "plus" and was added to the net water availability.

With the project, 814 ha.m are still available at the project site, while 1137 ha.m are available at Carquille in the probable use case.

5. Provide a more reasonable discussion of the "probable" case. Clearly identify the storage structures required for practical application of this case.

C.2 DISCUSSION - (Cont'd)

The probable use case is restricted by the amount of water available under present irrigation licences during the growing season (may-September). Presently water available for all-season irrigation appears to be fully licensed unless additional storage is developed. There is additional water available in Hat Creek during the spring which could be utilized for irrigating spring pasture.

The probable use case assumes that only the development of the potential corn land would need storage structures. The irrigation of other lands would be done using the estimated excess water available during the spring months. The irrigation water needed to irrigate the spring pasture would be 65 $ha.m.a^{-1}$. The development of potential corn land would require 67 $ha.m.a^{-1}$ with the project. As may be seen from Table C-1, this quantity would be readily available provided suitable storage facilities were constructed. It should be emphasized that except for the development of the potential corn land, the probable use case assumes the use of existing irrigation systems.

A review of Beak[10] shows that decommissioning would have many beneficial effects on irrigation water use (Table C-2). If these sources were used for irrigation an additional 280-2200 $ha.m.a^{-1}$ could be used to irrigate 308 ha to 2418 ha of land.

TABLE C-2

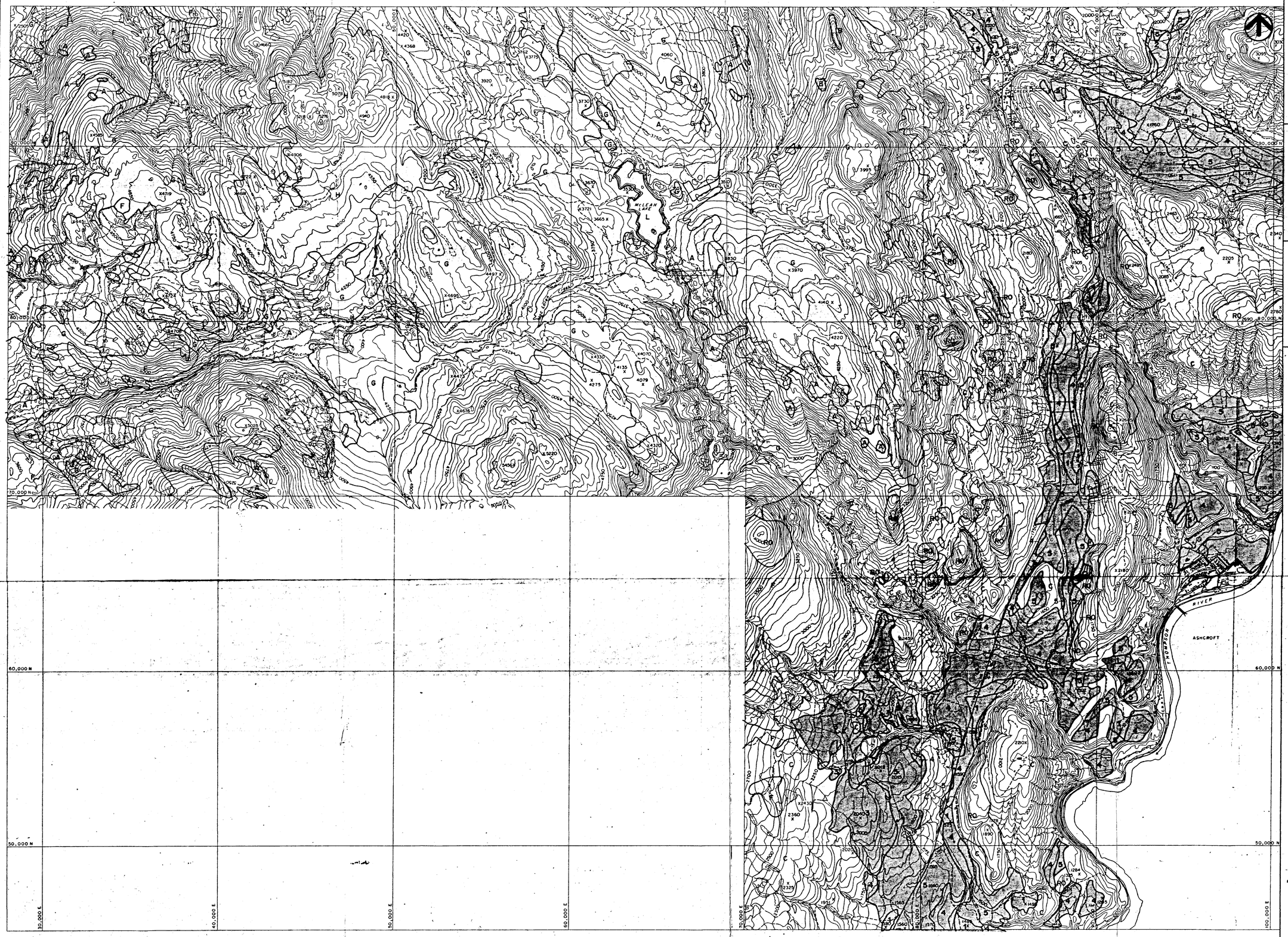
BENEFICIAL IMPACTS ON IRRIGATION WATER USE DUE TO PROJECT DECOMMISSIONING[1]

Project Activity		Cause of Benefit	Water Quantity ($ha.m.a^{-1}$)
Base Scheme:			
Supply Pipeline	-	Capacity (1.6 $m^3.s^{-1}$)	650
Plant Water Supply Reservoir	-	Storage becomes available	202-2122[2]
Pit Rim Reservoir	-	Storage becomes available	22
	-	Pump becomes available	-
	-	Evaporation of summer flow stops	3
Zero Discharge Reservoir	-	Storage becomes available	56
Mine and Slide Area Dewatering	-	Diversion stops	27[3]

1 From Table 9-21, Beak[10].

2 The larger quantity depends on supply from Thompson River and assuming optimum control of outlet works to utilize full reservoir capacity.

3 Possible negative impact if irrigation dependence on this water is developed during the life of the project.



B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT DETAILED ENVIRONMENTAL STUDIES

FIGURE 5-2b

PROBABLE USE WITHOUT PROJECT

SITE SPECIFIC STUDY AREA

PROBABLE IRRIGATED LAND

Rating	Preferred Crop *
1	Tomatoes
2	Corn
3	Cabbage
4	Hay
5	Irrigated Pasture

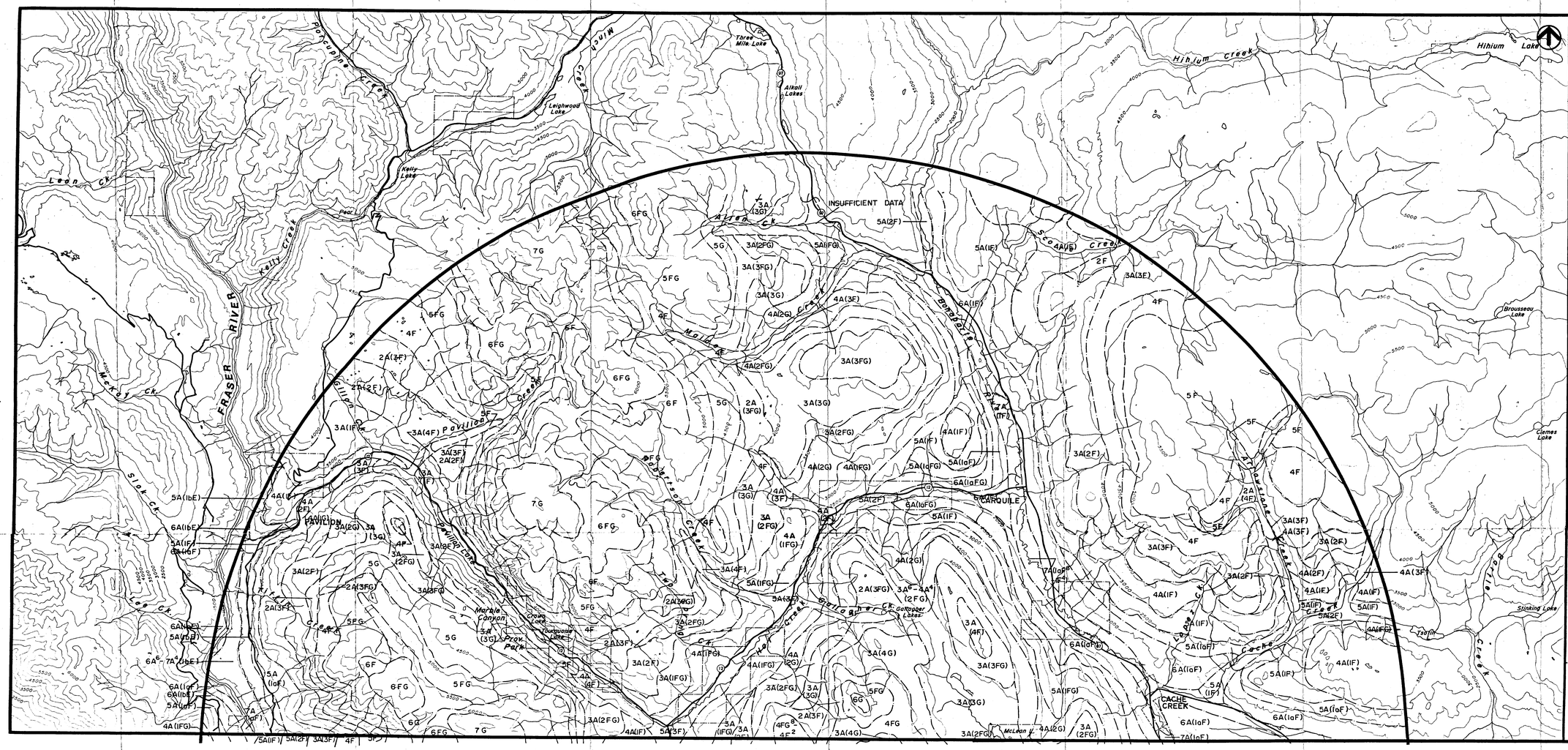
* indicates highest potential crop type; and is not a prediction of the crop that would actually be grown

PROBABLE RANGELAND

Rating	Vegetation Association
Spring Range	
A	Kentucky Bluegrass
B	Bunchgrass-Kentucky Bluegrass
C	Sagebrush-Bunchgrass
Summer Range	
D	Douglas-fir-Bunchgrass
E	Highland Grasslands (Alpine)
F	Douglas-fir-Bunchgrass-Pinegrass
G	Douglas-fir-Pinegrass
H	Engelmann Spruce-Grouseberry-Pinegrass
J	Engelmann Spruce-Grouseberry-White Rhododendron Engelmann Spruce-Subalpine Fir-Grouseberry Engelmann Spruce-Grouseberry-Lupines
L	Lake
RO	Rock Outcropping

2000 1000 0 2000 4000 6000 8000 FT

500 0 500 1000 1500 METERS



B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT DETAILED ENVIRONMENTAL STUDIES

FIGURE 4-6a REVISED CLIMATE CAPABILITY FOR AGRICULTURE

LOCAL STUDY AREA

CLIMATIC CAPABILITY CLASS LIMITATION

	FREEZE FREE PERIOD (DAYS)	GROWING DEGREE DAYS
Ib	< 150	1760 - 2059
Ia	120 - 150	1505 - 1779
1	90 - 119	1310 - 1504
2	75 - 89	1170 - 1309
3	60 - 74	1030 - 1169
4	50 - 59	1030 - 1169
5	30 - 49	780 - 1029
6	< 30	670 - 779
7	< 30	< 670

LIMITING SUBCLASSES

- A Drought or aridity between May 1st - Sept 30th. Moisture deficits limit plant growth.
- E Extreme minimum temperatures during winter season, injuring or killing dormant or near dormant fruit trees.
- F Minimum temperature near freezing adversely affecting plant growth during the growing season.
- G Insufficient heat units during the growing season.

EXAMPLE:

- unimproved (dryland) rating
- improved (irrigated) rating
- % of each map unit (ie 70% - 30%)
- $4A(3F^{7}\text{-}4G^{8})$: limiting subclasses
- capability class

Information Provided By:
Resource Analysis Branch
Climate Division

tera CONSULTANTS LIMITED

1 0 1 2 MILES

1000 0 1000 2000 3000 METRES

B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT DETAILED ENVIRONMENTAL STUDIES

FIGURE 4-6b REVISED CLIMATE CAPABILITY FOR AGRICULTURE

LOCAL STUDY AREA

CLIMATIC CAPABILITY CLASS LIMITATION

	FREEZE FREE PERIOD (DAYS)	GROWING DEGREE DAYS
Ib	< 150	1780 - 2059
Ia	120 - 150	1505 - 1779
I	90 - 119	1310 - 1504
2	75 - 89	1170 - 1309
3	60 - 74	1030 - 1169
4	50 - 59	1030 - 1169
5	30 - 49	780 - 1029
6	< 30	670 - 779
7	< 30	< 670

LIMITING SUBCLASSES

- A Drought or aridity between May 1st - Sept 30th. Moisture deficits limit plant growth.
- E Extreme minimum temperatures during winter season, injuring or killing dormant or near dormant fruit trees.
- F Minimum temperature near freezing adversely affecting plant growth during the growing season.
- G Insufficient heat units during the growing season.

EXAMPLE

4A(3F[7]-4G[3])

- unimproved (dryland) rating
- improved (irrigated) rating
- % of each map unit (ie 70% - 30%)
- limiting subclasses
- capability class

Information Provided By:
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Climate Division

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1 0 1 2 MILES

1000 0 1000 2000 3000 METRES