Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

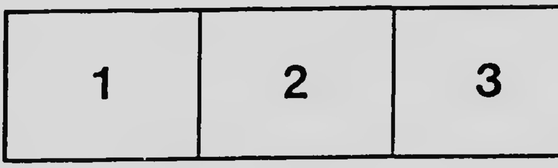
- [x] Coloured covers / Couverture de couleur
- [ ] Covers damaged / Couverture endommagée
- [ ] Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- [ ] Cover title missing / Le titre de couverture manque
- [ ] Coloured maps / Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- [ ] Bound with other material / Relié avec d'autres documents
- [ ] Only edition available / Seule édition disponible
- [ ] Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- [ ] Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- [ ] Additional comments / Commentaires supplémentaires:

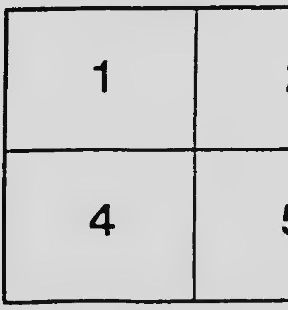
L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured pages / Pages de couleur
- [ ] Pages damaged / Pages endommagées
- [ ] Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- [ ] Pages detached / Pages détachées
- [x] Showthrough / Transparence
- [ ] Quality of print varies / Qualité inégale de l'impression
- [ ] Includes supplementary material / Comprend du matériel supplémentaire
- [ ] Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.
- [ ] Opposing pages with varying colouration or discolourations are filmed twice to ensure the best possible image / Les pages s'opposant ayant des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleure image possible.

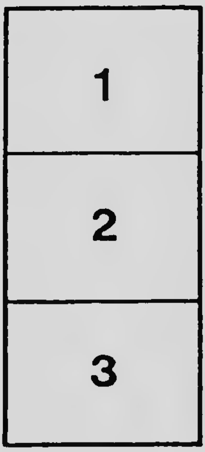
This item is filmed at the reduction ratio checked below / Ce document est filmé au taux de réduction indiqué ci-dessous.

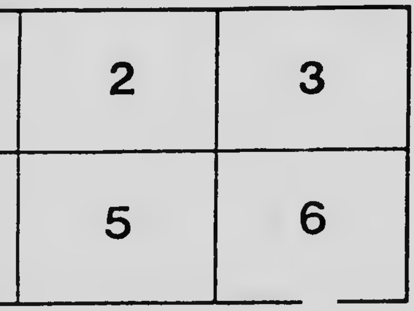
10x	12x	14x	16x	18x	20x	22x	24x	26x	28x	30x	32x
										✓	


1
2
3


1
4


3


1
2
3


2
3
5
6

City of Kamloops, B. C.

PRELIMINARY REPORT

ON THE

PROPOSED HYDRO-ELECTRIC DEVELOPMENT

BARRIER CREEK

DUTCHER, MAXWELL & CO.,

Engineers and Surveyors

VANCOUVER, - - B. C.

August 12, 1911

SENTINEL KAMLOOPS

PRELIMINARY REPORT

August 12, 1911

The Mayor and Council,
Kamloops, B.C.

Gentlemen,—In accordance with your instructions we have carried out an examination of the Barrier creek, for the development, if possible, of 5000 h.p. hydro-electric

We have also made preliminary plans and estimates for the construction of a new steam power and pumping plant, designed for any necessary extension and equipped to operate with or without hydro-electric power.

We have included in this section of our report alternative plans and estimates of a new concrete covered reservoir having a capacity of 1,000,-000 gallons

In order that you may at once have before you our own views with reference to development and initial construction, which may be studied more in detail from an examination of the complete report, including plans and photographs, we submit the following summary.

SUMMARY

Hydro-Electric Plant

The development of 5000 h.p. from the Barrier creek is feasible and can be carried out without any serious or costly problems of construction, provided you confine yourselves to an initial development of from 1800 to 2000 h.p. making use, as far as seems practicable, of timber construction for flume and intake dam, designed as part of the complete development.

The more permanent but more costly concrete construction may be carried out at a later stage of development when the available market for power and the transport of material and equipment by rail would warrant.

The initial development of from 1800 to 2000 h.p. can safely be made at a cost not to exceed $95 per h.p. peak developed, or say $119 normal, and by more extended use of concrete the cost may be as high as $120 per h.p. peak or $150 normal developed.

Under similar conditions in respect to character of the work, the cost of developing the full 5000 h.p. will vary from $80 to $105 per h.p. peak of energy developed; $106 to $140 normal.

The plentiful supply of good timber along this creek, together with the fact that a timber flume when running full throughout the year, is much more permanent than an irrigation flume alternately wet and dry, are points in favor of the cheaper construction, while the cost of construction can be estimated to a much greater degree of accuracy than in the case of concrete work, and the decreased annual fixed charges would favorably affect the revenue when most needed.

Steam Plant

The accompanying proposed plan of the new steam power and pumping plant, provides for plant equipment of 1000 h.p. initial capacity at an estimated cost of $90,000, and located on lot 137.

The high duty pump, the new boiler and the new 200 k.w. generator set of the present plant is included in the plant of the new power house

The principal features of the proposed plan, worthy of special notice, are the arrangements for extension and the arrangement of multi-stage, electrically-driven centrifugal pumps, which will be operated either direct from the hydro-electric power, or from the 500 k.w. steam turbo-generator set, provided, and having a capacity sufficient for both the electric lighting and pumping loads

The well is placed clear of the pumps and will have a three-foot intake

Reservoir

The site favored for the new reservoir is on the Beckman addition between Eighth and Ninth avenues and having the same elevation as the present reservoir.

The accompanying proposed plans provide for a covered concrete reservoir of 1,000,000 gallons capacity, and the cost of construction including main is estimated to be $28,000.

PROPOSALS

For the immediate requirements, two alternative proposals are suggested for consideration

Proposal 1. The initial development of 2000 h.p. from the Barrier creek at a cost not to exceed $190,-000; the purchase of a 1,000,000 gallon per day capacity centrifugal pump designed for the new power house, but temporarily installed at the present power house, cost, complete with motor $5500, and the construction of a 1,000,000 gallon capacity reservoir at a cost of $28,000 including main. Total expenditure $223,500; the present plant to act as a reserve until the construction of a new steam plant at a later date

Proposal 2. The construction of a new steam plant after the design submitted, with 1000 h.p. initial capacity and having pumping plant for 2,500,000 gallons per day, will cost $90,000, and the construction of a new reservoir and main at a cost of $28,000 initial expenditure for 1000 h.p. plant, making a total of $118,000.

For a basis of comparison between the annual cost of a steam plant of 2000 h.p. and a 2000 h.p. hydro-electric plant, having a 1000 h.p. steam plant reserve, it may be stated that in general the difference in favor of the hydro-electric plant will be the annual cost of coal for the 2000 h.p. steam plant, if the capital costs and labor charges are the same, and the cost of coal for 1000 h.p. plant for Kamloops under the best conditions may be taken at $28 per h.p. per year. The present cost of coal per h.p. per year is $13.

Taking the capital cost of the steam plant as 60% of the cost of the hydro-electric and reserve steam plant combined, then the saving effected by the hydro-electric plant will be the cost of coal less the difference between the annual fixed charges in the two cases.

Thus taking the 2000 h.p. hydro-electric plant to cost $190,000, and steam reserve of 1000 h.p. to cost $60,000, a fixed charge of 11% would represent $27,500; for a 2000 h.p. steam plant costing $100,000, the fixed charge would be $11,000. Taking cost of coal at $28 per h.p. per year the total cost of coal would be $56,000, and a saving of $56,000 less $16,500 or $39,500 per year, $19.25 per h.p. would be effected by the hydro-electric plant in this case. This approximately represents the saving you may expect on the 2000 h.p. plant with the market for this amount of power. The comparison, therefore, seems in favor of proposal number one, setting aside the indirect benefits to the city from the greater developments of the lands along the river by irrigation. Generally speaking the cost of hydro-electric power varies from about $60 to over $200 per h.p. developed, the average cost for plants of this size being about $100 per h.p., but hydro-electric power may cost as high as $180 to $200 and still remain in favorable competition with steam power, where the cost of only an average grade of coal comes to above $1.20 per ton.

Your present cost of power is hardly a fair basis for comparison of steam plant and hydro-electric, where your pumping plant load is about 140 h.p. and the peak load of the electric plant is 250 h.p.

With the load you have the cost per h.p. per year varied between $80 and $110 per h.p. per year, according to the load factor, and the cost of coal alone is about $13 per h.p. per year.

On the basis of 2000 h.p. development the cost of power delivered to city station will be about $16.40 per h.p. per year without the reserve steam plant, and $21.50 per year with the steam plant.

On the same basis the cost of 2000 h.p. steam plant will be between $48 and $50 per h.p. per year, including all fixed charges the coal costing about 60% of the total charge.

Reduced to a k.w.h. basis a cost of $16.40 per h.p. on 10% [illegible] corresponds to about [illegible] and 1c per k.w.h. with [illegible] factor 30%.

A charge of $45 per h.p. corresponds to 1.7c per k.w.h. on a 10% load factor.

The annual charge of $33,100 on the hydro-electric plant will be paid for by 750 h.p. power, on a valuation of $45 per h.p. per year or 1.7c per k.w.h. load factor 40%.

The annual charge for coal alone on your present plant with output of 240 h.p. electric and 140 h.p. pumping is about $16,000, or about half the total annual charge on the 2000 h.p. hydro-electric plant.

Market

In addition to the power sold in the city, about 1000 h.p. will be required for four months for pumping water from both Thompson rivers to the lands which cannot obtain water for irrigation purposes otherwise.

The revenue from this source alone, estimating for 4000 acres, should bring a return of from $3 to $4 per acre, in addition to the first charge of say $10 per acre toward cost of transmitting power.

Outside of these lands the market is problematical, although the settlement of lands along both rivers will create demand for power and lighting, which will in time require the further extension of the hydro-electric development to its full capacity, but for initial development, 2000 h.p. is, in our opinion, the safe and proper course to follow until conditions are more fully understood.

The data and detailed analysis from which the above summary is drawn follows in part one and part two of this report.

PART 1

HYDRO-ELECTRIC POWER FROM THE BARRIER CREEK

General Hydrography

The Barrier creek flows into the North Thompson river about forty miles north of Kamloops.

The accompanying map shows its course and upon referring to this you will note that about 12 miles from its mouth there are two forks, the North Barrier and the East Barrier. Both forks have their sources in the mountains forming the watershed between the Adams lake and the North Thompson river, and both flow through large lakes, which have splendid storage basins for the control of the flood flow of the creek.

The North Barrier lake is on the main branch of the creek and about eight miles above the fork. It is six miles long and has an area of about 3600 acres

The East Barrier lake on the east fork is about 4½ miles above the fork. It is about eight miles long and has an area of about 5000 acres. The flow from this lake, however, is about one-quarter of the flow from the north lake

Both lakes are about 2100 feet above the sea level.

The total drainage area tributary to the site of the intake is not accurately known on account of the absence of survey, but is at least 230 square miles, and while there is no authentic data in regard to precipitation, evaporation and run-off, we found on measuring the creek last September 21th for the Imperial Power Company, Limited, that the flow was about 280 second feet. As the time this measurement was taken represents the low water flow of a dry year, we therefore assume a minimum flow of about 300 second feet

At the time of our examination of the creek last July 28th, we found the flow of the main creek to be about 750 second feet, about 80% of which came from the north branch.

The accompanying hydrograph curve estimated from the measurements taken gives a probable maximum flow of about 2000 second feet, but this will be very carefully corrected before the full 5000 h.p. is required.

The character of the country about the creek is shown by the accompanying photographs.

The whole drainage area appears to be mountainous and heavily timbered with fir, spruce and cedar, and in some parts covered thickly with small growth

There is a heavy snowfall during the winter and the mean annual rainfall should not be less than 30 inches

We understand from the settlers located along this creek that there are short periods of severe cold approaching thirty degrees below zero, and some effect from this may appear occasionally in the penstocks.

DEVELOPMENT PROGRAM

The grade of the creek from its mouth to the forks averages about 50 feet per mile up the north branch and about 70 feet per mile up the east branch.

Our instructions were to locate, if possible, a site for the development of 5000 h.p. and after carefully going over the ground we decided in favor of the location which has been applied for and which is almost the identical site we reported on last year for the Imperial Power company, limited, and which was to be included in our report to you on available water powers, this summer.

This provides for the power house about one and one-half miles from the mouth of the creek, and the intake about three miles farther up the creek, and on making a survey of the creek between these points a grade of about 58 feet per mile was found

Taking into account the elevation of the intake, a head of about 190 feet can be obtained and this, with a flow of about 500 second feet will give a 6000 h.p. development.

The location favored and estimated upon will give a maximum development of 5000 h.p. and is shown as scheme number one, and this we deal with in detail.

The development will provide for the construction of an intake crib dam, 15 feet high, 13,500 lineal feet of timber flume or concrete lined canal, concrete forebay, and steel penstocks, from the forebay to power house, a distance of about 800 feet

The power house will be located as shown and of reinforced concrete construction with provisions for extensions

The route of the flume line is along the south side of the creek, with conditions favorable for easy grading and economical construction of flume.

A right-of-way will be cleared so that the flume will be protected from forest fires and should the initial development of 2000 h.p. be decided upon, the grading of the flume line shall be made to provide ample room for extension of flume for increased capacity, or construction at a later date, of a concrete lined ditch, covered over

We have selected the south side in preference to the north side on ac-

count principally of the sand bill banks shown in photograph, and the better location to be obtained.

The hydraulic and electrical equipment will be of the usual type for the given head, in units of 1200 h.p. each designed for direct connection.

The electric power will probably be generated at 2200 volts, three-phase and 60 cycle, stepped up to 41,000 volts for transmission or less than this with Delta connections and later raised to higher voltage by Y connections.

A road will be made to the power house and extended down to the North Thompson river, where a small wharf will be built for unloading materials from steamboats and loading poles for convenient points along the route of the transmission line.

The transmission line will be designed in two separate three phase circuits for the full capacity of 5000 h.p. but only one circuit will be placed for the initial development of 2000 h.p.

No. 6 B. & S. copper wire will probably be used and spaced 48 inches apart with insulators of the usual high voltage type.

Very little trouble is expected in the operation of the line in view of the absence of severe lightning storms, and the dry nature of the climate.

The poles will be of the standard transmission line height and spaced not closer than 44 to the mile, or in the event of using suspended insulators, 25 to the mile.

Cedar poles are obtainable along both the Barrier and Louis creeks, and on account of the character of the soil on the route these may have to be treated for protection against decay.

Although allowance is made in the estimates for right-of-way it is expected that the cost of the right-of-way will be paid for by the owners of the lands which require irrigation, in fact an arrangement should be made as in the case of irrigation companies, by which a first payment of say $10 per acre will be required before connections are made for the power, this to be applied toward the cost and maintenance of the transmission line.

HYDRO-ELECTRIC POWER

1800-2000 h.p.

Estimate of Costs

Generating Station—	
Dam and intake works	$12,000
[illegible] feet flume in place	29,700
Gates, screens, etc.	2,500
Steel penstock 800 feet	8,800
Clearing, grading, etc	2,000
	$55,000
Power Plant—	
Power house and foundations	$ 8,000
Two 1200 Francis type turbines with governors	14,500
Two 600 k.w. generators for direct connection with exciters and switchboard	16,000
Two sets of step-up transformers	12,000
	$50,500
Transmission Line, 39 Miles (one circuit)—	
Poles placed and fully equipped with insulators, per mile	$ 780
1260 No. 6 copper wire and labor placing, per mile	280
	$ 1,060
39 miles at $1060 per mile	$ 41,340
Right-of-way expenses	5,000
	$ 46,310
Sub-station—	
Sub-station and step-down transformers for 600 k.w.	$ 8,000
Total	$159,840
Add 10% for contingencies	15,160
Engineering 7½%	15,000
	$190,000

Capital cost per h.p. $95.

Note—The estimate of $50,500 on plant equipment may be exceeded after tenders are submitted on detailed plans, but any excess in this case will be balanced by the allowance for contingencies, and expected lower cost of flume line.

ANNUAL OPERATING COSTS

Generation 1800-2000 h.p.

Operating Expenses—	
Superintendent, half time at $2000	$ 1,000
Bookkeeper	900
Stationery, etc.	500
	2,400
Power House and Line—	
Two operators at $1200	$ 2,400
Two sub-station men	2,400
Two linemen at $1200, half time	1,200
Two laborers at $900	1,800
	$ 10,200
Maintenance Depreciation—	
Works 4% on $80,000	$ 3,200
Equipment 6% on $95,000	5,700
	$ 8,900
Interest and sinking fund 8%	11,600
Annual charge, 2000 h.p.	$ 33,100

Charge per h.p., $16.55.

Charge per h.p. with steam plant reserve, $21.50.

Amount of power necessary to meet annual hydro-electric charge at $45 per h.p. per year, 750 h.p.

Note—$45 per h.p. per year corresponds to a charge of 1c per k.w.h. on a load factor of 50% or 2c on load factor of only 25%.

PART II

STEAM POWER PLANT AND RESERVOIR

For water supply service it becomes necessary to use a type of pump adaptable to electric motor drive, a condition to which the high duty plunger type of pump as at present installed is not well suited. We have adopted the multi-stage turbine pump as being entirely suitable for the new units, utilizing the present steam driven high duty pump as an auxiliary reserve.

The turbine pump is of rotary motion delivering [illegible] rated quantity of water with an entire absence of pulsation, and is to be driven by an electric motor arranged on vertical shaft. The motor can thus be installed on the engine room floor, the pump working at the proper elevation in the pit beneath. Such a pump, capable of delivering 1,000,000 gallons per 24 hours [illegible]der future pressure conditions will require 125 h.p. motor. This can be thrown in and out of service with great facility and with the present unit will furnish a total supply of 2,500,000 gallons of water per day.

It would be better practice, however, to install two such pump units as with a duplicate available, [illegible] continuous and ample supply of water to the consumer would be assured. The low first cost of these units renders this feasible as the complete equipment per unit amounts to only $5500, as against approximately $12,000 for a steam-driven high duty unit of similar capacity.

In order to provide ample electric power for present needs and to supply the turbine pumps, we recommend the installation of a 500 kilowatt steam turbo alternator at a total cost of approximately $17,500.

This will not only furnish ample power for both electric pumps, but will have a margin of power sufficient to run the entire electric output in addition, leaving the present 200 k. w. direct connected set for reserve and light load periods.

To supply steam for this turbo generator and for the present high duty unit which is to be removed to the new site, we recommend the installation of 500 h.p. in two 250 h.p. units of water tube boilers, and one 150 h.p. return tubular boiler. The latter is to be set in battery with the newer return tubular boiler of the present plant, and the water tube boilers will form a second battery.

The latter on account of rapid steaming qualities and capacity for being forced to overload, are particularly well adapted to provide reserve for hydro-electric power in case of interruption through transmission, breakdown, ice or other causes, while the former will provide an inexpensive and independent steam supply for the high duty pump and auxiliaries, which are unsuitable for the utilization of the high pressure superheated steam served out by the water boilers for a steam turbine.

Under the above arrangement a new plant equipped with the turbine e[illegible]e and turbine pumps can be installed and placed in operation without disturbing the existing plant. Then the high duty pump, the 200 k.w. set and the good boiler may [illegible] removed and placed at the new location without interruption of service. The 120 k.w. belt-driven unit with engine, condenser and switchboard panel may be sold, as on account of its large capacity and the fact that its installation requires some 60 feet of longitudinal floor space, it would not be good economy to provide for its accommodation in a new building.

The two older boilers at the present plant may be scrapped, as they are not worth the expense of removal and the cost of providing space in a new plant.

We submit herewith a sketch design which we suggest as providing an extremely adaptable and flexible plant, permitting of easy expansion in all essentials, and of the utmost reliability. It not only provides an ample capacity for both pumping and electric supply, but is ideal as an auxiliary and reserve to cover any interruptions in the future supply of transmitted power for 1000 h.p. initial capacity.

The estimated new exp[illegible]iture for this plant is $90,000, at [illegible] % of which is for power hou[illegible] [illegible]ll and intake.

The detailed estimates are as follows:

Estimate of Cost—Steam Power and Pumping Plant

1000 h.p. Initial Capacity

Power house building	$ 21,500
Intake, well and pump room	12,000
Equipment—	
One new 150 h.p. return tubular boiler	2,500
Two new 250 h.p. water tube boilers with superheaters	9,000

Stack for all and breeching	2,000
Steam lines and labor	1,500
Steam turbine 500 k.w.	17,500
Switchboard complete	2,500
Removing present machinery	1,500
Centrifugal pump motor	5,500
Miscellaneous, wiring, piping, etc.	1,000
Travelling crane	2,000
Railway spur	1,500
Land for site	5,000
	$ 86,750
Contingencies 5% say	4,250
	$ 91,000
Engineering 5%	4,550
	$ 95,550
Credit belted set and land, say	5,550
New expenditures	$ 90,000
Allow for 200 k.w. generator set	10,000
New boiler	2,200
Condenser, etc.	2,800
Present plant	$ 15,000

Total capital cost 1000 h.p. steam plant including well and pumping plant, $105,000

Capital cost per h.p., $105

Estimated cost of power per year, load factor 10% is including all charges, $55 per h.p.

This represents a cost of 2c [illegible] k. w. h., about half the present power costs, and may be exceeded slightly.

Note—An estimate made by the hydro-electric power commission of cost of power from 1000 h.p. steam plants in Ontario was $42 per h.p. per year, 24-hour power, and this should be increased by at least 30% to meet labor and other conditions in Kamloops.

Reservoir

The accompanying plan showing two alternative types of reservoirs should after test pits have been made to determine the character of the ground to be excavated, be followed at a later date by detailed design and detailed estimates and the total estimate of $28,000 may be exceeded by $1000 or $5000 should much hardpan or rocks be encountered.

Respectfully submitted,

Dutcher, Maxwell & Co.

Per H. K. Dutcher

APPENDIX A

HYDRO-ELECTRIC POWER

5000 h.p.

Estimate of Cost

Intake Works—

Storage dam, North Barrier lake	$ 15,000
Intake dam and gates	20,000
13,500 feet timber flume of 500 second feet capacity	61,000
Forebay, gates and spillway	4,800
Penstock to power house	22,000
Clearing and grading	4,500
	$127,300

Power Plant—

Power house and foundation	$ 18,000
Five Francis type turbines with governors 1200 h.p. each	36,250
Five 600 k.w. generators, exciters and switchboard	38,000
Step-up transformers	30,000
	$122,250

Transmission Line—Thirty-nine Miles—

Poles placed and equipped with insulators at $1005 per mile	$ 39,195
Copper wire and labor placing at $625 per mile	24,375
	$ 63,540
Two sub-stations with step-down transformers and switchboard equipment as	$ 38,000
	$351,120

Note—Only one sub-station with 600 k.w. transformers was included in the 1800-2000 h.p. estimate, as the second 600 k.w. set should be paid for with sub-station by the sale of power for irrigating lands.

	$351,120
10% contingencies, say	35,880
	$387,000
5% engineering	19,350
	$406,350

Cost per h.p. (5000), $81.

The above capital cost for the 5000 h.p. development would increase the difference between timber and concrete canal 13,500 feet and extra construction of power house and transmission line.

Concrete	Timber	
$103,000	$61,000	42,000
35,000	20,000	15,000

Power House—

Heavier steel and concrete construction to $24,000 from $18,000	6,000

Transmission Line—

Concrete filling for bases at $8 per pole, 1000 poles	$ 8,000
Substations, extra construction	4,000
	$ 75,000
	351,120
	$426,120
10% contingencies	42,880
	469,000
5% engineering	23,450
Total capital cost 5000 h. p.	$492,450
Cost per h.p., $99	

Annual Charges—5000 h.p.

General—

Superintendent	$ 2,000
Bookkeeper	1,200
Stationery	1,000
	$ 42,000

Power House—

Two operators	$ 2,400
Sub-station men	4,800
Two linemen	2,400
Two laborers	1,800
	$ 11,400

Maintenance and Depreciation—

Works, 3% on $165,000	$ 4,950
Equipment 5% on $240,000	12,000
Interest and sinking fund, 8% on $406,000	32,480
	$65,030
Annual cost per h.p.	$ 13
With 1000 h.p. steam plant reserve at $6	6
	$ 19

APPENDIX B

NOTES ON SALE OF POWER FOR IRRIGATION, ETC.

In the course of our examination of the lands along the North Thompson river and the streams and lakes available for the irrigating of these lands, we have estimated that there are between 4500 and 5000 acres of land available for irrigation by pumping from the river, and about 3000 acres of the upper lands which may be better irrigated from the Heffley, Sullivan and Badger creeks.

From our present fairly thorough knowledge of these creeks we are certain that these streams with storage cannot provide sufficient water for more than half the above total acreage of 8000 acres, and with hydro-electric power available a complete system of irrigation can be obtained by using the streams, as suggested, for the upper lands, and electric power pumping for the lower benches.

With large irrigation companies it is common practice to make a first charge of from $10 to $20 per acre toward first construction of the system and an annual charge of from $2.50 to as high as $5 per acre per year for water.

In the course of the construction of the hydro-electric plant for Kamloops it will be advisable to introduce some such plan for the sale of power to those lands needing such for pumping, and a first charge of $10 per acre toward the construction of the system would appear reasonable and would reduce your capital expenditure by about $40,000 and also reduce your annual fixed charges in near proportion.

As the difference in value between unirrigated and irrigated lands varies from $60 to $100 per acre for large tracts, a charge of $10 per acre to obtain this difference ought to impress the land owners favorably, and whether the arrangement, for annual charges for power is by meter or per horse power rating of the motors in service, is a matter to be studied further, but the estimate of a revenue of $3 per acre is conservative and safe.

Assuming the mean elevation of the benches to be 40 feet above the river, 4000 acres will require about 550 h.p. allowing for losses and taking the duty of water at 1 second foot per 100 acres during the irrigating season.

There will also be at least 500 h.p. required in small lots of from 5 to 50 h.p. on the different ranches, and this should be an annual load at charges of from $120 per h.p. per year for 5 h.p. loads to about $50 per h.p. per year for 50 h.p. loads, with prices graded to suit powers between these.

Hence, from initial development a revenue of about $12,000 should be obtainable from sale of 500 h.p., power for irrigation, and another 500 h. p. should be sold at an average price of at least $60 per h.p. making a total revenue from both of the above sources of $42,000.

Add to this a sale of say 1000 h p. to the city at $45 per h.p. will make a total revenue of about $87,000 per year; or at $30 per h.p., $72,000.

Deducting an annual charge as high as $45,000 leaves a profit to the city of from $27,000 to about $42,000 which

may be applied either towards future construction or reducing your own power rates to say half the above valuation, or you may make both a considerable reduction in the rates to the consumer, and also set aside part of the profits toward future construction, a course which seems wise.

The proposal of the city of Kamloops to develop hydro-electric power, not only enough to serve the requirements of a normal growth, but also to stimulate by cheap power an industrial development due the city from the natural advantages of its position, should be attended with complete success from the development of power from the Barrier creek along the general lines of our proposal, namely, to plan for 5000 h. p. but to carry out initial development of not more than 2000 h.p.

This particular stream, as already stated, has particular advantages for safe construction and operation of works with the two large storage lakes to control the flow and the operation charges will be low enough to enable the city to make from its revenue a considerable profit, after making a substantial reduction in rates to the consumer, and the enterprise is only one of several such municipal enterprises now being undertaken by western cities, including Calgary, Edmonton and Prince Albert

Respectfully submitted,

Dutcher, Maxwell & Co.

Per H. K. Dutcher.

APPENDIX C

August 28, 1911

The Mayor and Council,
Kamloops, B.C.

Gentlemen,—We note from the report on the meeting of the council last Thursday that a wish was expressed to have also an estimate on the cost of 1000 h.p. development from the Barrier creek.

Our instructions were to report on the cost of a 5000 h.p. development and also a 2000 h.p. development, and we have given you this in our report

We are pleased, however, to also give you our estimate on the cost of 1000 h.p. development from this creek and submit this as appendix C of the complete report.

From the estimates given you will note that the estimated cost of developing 1000 h.p. is placed at $165,600 or $155.60 per h.p., and this is arrived at in the following manner.

By construction of a smaller flume 5 feet by 4 feet the cost of the flume can be reduced by about $9200 and penstocks by $3000, making a reduction of $12,200 in this case.

In the power plant equipment the estimated cost is reduced from $50,500 to $32,500.

No reduction can be made on the transmission as No. 6 wire is the smallest size permitted and no reduction should be made for sub-station.

ESTIMATE OF COST—1000 H.P.

Hydro-electric Development From Barrier Creek

Dam and intake works	$ 12,000
13,500 feet flume, in place	20,500
Gates, screens, etc.	2,500
Steel penstock, 800 feet, in place	5,800
Clearing, grading, etc.	2,000
	$ 42,800

Power Plant—

Power house and foundations	$ 8,000
Two 600 h.p. turbines, placed	9,000
Two 400 k.w. generators, exciters and switchboard	9,500
Two sets step-up transformers	8,000
	34,500
Transmission line (as in 2000 h.p. estimate)	$ 49,340
Sub-station	8,000
	$131,640
Contingencies 10%	13,160
Engineering 7½%	10,800
Total	$165,600

Annual Operating Expenses

1000 h.p.

Operating—

Power plant and line same as 2000 h.p.	$ 10,200
Maintenance and Depreciation—	
Works 3% on $80,000	$ 2,400
Equipment 6% on $70,000	4,200
	$ 6,600
Interest 5%	7,780
Total annual charge for 1000 h.p.	$ 24,580

Annual charge per h.p., $24.58.

As a note to the above estimates we should state that you cannot obtain 1000 h.p. from this creek at a lower cost by a higher head development, for the reason that the creek has a certain fixed grade averaging 50 feet per mile, and to obtain double the head or say 300 feet it logically follows that you will require to construct at least double the length of flume, and the smaller cost per lineal foot by using less water, and hence the smaller flume, is more than offset by the double length of flume required. For example, 1000 h.p. development may be obtained by 150 foot head with about 90 cubic feet of water per second. With a velocity of 6 feet per second, this will require a water section of 15 square feet, or 5 foot by 3 foot flume. With double the head or 300 feet and half the water or 45 cubic feet per second, a water section of 7½ feet will require a 4 foot by 3 foot flume.

The 5 foot by 4 foot flume will cost about $1 50 per lineal foot, in place, and the 4 foot by three foot about $1 15 in place, including grading, etc. Hence, three miles of 5 foot by four foot flume will cost about $24,000, against six miles of 4 foot by 3 foot flume costing $35,-[illegible], which clearly indicates the high-[illegible]st of endeavoring to obtain a [illegible] head development from a low [illegible]ad stream.

There is also the greater danger from frost with the smaller quantity of water, and the loss of head by the necessity of a greater grade for the smaller flume will be considerable.

Note—In preference to the above proposal for 1000 h.p. initial development we would favor the planning of the flume, penstock and equipment for the 2000 h.p. units as given in the estimate (previously given) and instead of installing at once, the two turbines, two generators and two sets of transformers, you install only the one set first or duplicates of half capacity each and use the steam plant as a reserve. This will do for a year or possibly more, but in view of the sale of power for pumping, etc., it would be advisable to duplicate units installed as soon as funds would be available, for the purpose of providing against any temporary breakdown of units.

The detailed estimate on this arrangement for the first 1000 h.p. would be the same as estimates for the 2000 h.p. (as previously given) except that the power plant equipment would be.

Power house	$ 9,000
One 1200 h.p. turbine or two 700 h.p.	8,000
One 600 k.w. generator or two 400 k.w. switchboard	9,500
One set of transformers or two sets	7,000
	$ 33,500
This is a reduction of $50,-500 - $32,500 equals	$ 18,000
$159,840 - $18,000 equals	$141,840
Contingencies 10%	14,160
	$156,000
Engineering 7½%	11,700
	$167,700
Total for 1000 h.p., say	$168,000

Cost per h.p., $168.

Annual operating charges about $25

The total expenditure would, therefore, be:

1. Hydro-electric power (one thousand h.p.) initial to be brought up to 2000 h.p. by a further expenditure of about $10,000 as soon as possible	$168,000
2. Centrifugal pump, 1,000,-000 gallons per day	5,500
3. Reservoir, 1,000,000 gal-capacity	28,000
Total	$201,500
Allow, say	$205,000

The above represents what seems to us the minimum expenditure which should be made with development of power from the Barrier creek, and we believe it would be advisable to plan for the 2000 h.p. development even though the available funds may limit you to a first installation for only 1000 h.p. as above proposed.

In any case we think that the flume should be built for 2000 h.p. capacity and you may at once provide duplicate units of 400 k.w. capacity as given previously in this appendix, making your total initial expenditure for plant, pump and reservoir about $205,000.

Respectfully submitted,

Dutcher, Maxwell & Co

Per H. K. Dutcher.

APPENDIX D

TO PRELIMINARY REPORT BARRIER CREEK POWER SCHEME

2000-10,000 h.p.

The Mayor and Council,
Kamloops, B.C.

November 10, 1911

Gentlemen,—When our report on the proposed power development from the Barrier creek was submitted to you we had followed your definite instructions to obtain a location for a maximum development of 5000 h.p., or ten times your present load.

We therefore based our work on these instructions and showed three alternative schemes to obtain the required amount of power, giving you preliminary estimates on our scheme for initial development of 2000 h.p. and final development of 5000 h.p.

We now understand from the discussion on this project last Thursday that there is a desire on the part of some to now have a location and estimate for at least 10,000 h.p., and as this is beyond the limit of our first instructions we therefore include our proposal and estimate on this project as appendix D of the report submitted.

We propose that you plan for the initial development of 2000 h.p. using the approximate location shown on plan submitted as scheme number three, and located on the north side of the creek, but moving the intake about a mile higher up, to have the power house placed in position for the final development of 10,000 h.p.

To obtain more than the 5000 h.p. originally planned for it will be necessary to increase the head. For development as high as 10,000 h.p. or more, at least 400 feet head would be necessary, as the flow is practically limited to that recorded, using the storage capacity of the lakes.

A head of 400 feet can be obtained by about 6½ miles of canal flume or pipe system from the intake down along the north side of the creek, and taking the desired initial development of 2000 h.p into account there are several alternative schemes open for consideration.

One scheme would provide for the construction of 6½ miles of flume, designed to eventually carry about sufficient water for about 12,000 h.p. development.

Such a flume would need to have . width of about 12 feet and for from 2000 h.p. to 4000 h.p. should have a depth of not less than three feet, the sides of the flume to be increased for greater h.p. when required.

The initial cost of this flume would be not less than $4.25 per foot or $146,000 for the 6½ miles.

The interest and depreciation charge on this construction alone would be about $17,500 per year, or about $11 per h.p. of the 1600-2000 h.p. To complete the development for this power would require another $160,000 making a total of say $310,000, a very heavy charge to carry, being nearly $200 per h.p. developed, with an annual charge of over $45,000, or about $28.50 per normal h.p.

This therefore should be set aside.

A second scheme is to construct the flume for about 5000 h.p. This would take a 7 foot by 5 foot flume costing, in place, about $2.50 per foot, making a charge of about $86,000 for the 6½ miles, and the initial development of 1600-2000 h.p. would then cost about $216,000 or $154 per h.p. normal, with an annual charge of about $21.60 per h.p.

A third scheme would provide for the construction of a covered concrete lined ditch for full capacity to eventually give 10,000 h.p. or more. This would cost from $10 to $14 per foot, and is therefore prohibitive for the 1600-2000 h.p. development ,but would be a very sound plan of construction for from 5000 h.p. to 10,000 h.p. development, as the work would be practically permanent with a low fixed charge, and would cost less than wood or steel pipe of equal capacity, the life of which would not be more than 12 or 15 years.

Moreover, less than 17 feet head would be lost in the 6½ miles corresponding to a loss of about 550 h.p. for the 500 second feet flow, whereas with a pipe of equal capacity a loss of head of over 60 feet would occur, and this corresponds to a loss of about 2000 h.p., requiring an extra mile of pipe.

The use of pipe is practical only for short distances or where the available head is great enough to allow considerable loss by pipe friction.

The above analysis explains our objection to the use of a long line of expensive pipe for this project, the cost of which would be from $14 to $20 per foot, depending on the head, and which would have to be renewed in 12 or 15 years by the construction of an entirely new line to keep the plant in operation, necessitating a new intake higher up to enable the new pipe line to clear the old line.

It is our opinion that a covered concrete lined canal or ditch is the only practical and permanent construction to recommend for the complete development of from 5000 to 10,000 h.p., and when the market ar-

rives for this amount of power such permanent and economical character of construction would be well warranted.

In the meantime, for the development of the 1600-2000 h.p. immediately required, the adoption of any of the schemes above discussed would place a very heavy annual charge upon your plant for some years, with financial returns from only part of the possible development.

PROPOSAL

We therefore propose that you obtain the water rights for the complete development with the 100 feet head and about 6½ miles of concrete lined canal, making the point of diversion to apply for about four miles above the present point. Or you may possibly obtain, if you so desire, the power rights from the forks to the bridge, as a point of return.

Having your rights secured in this respect, we propose that you adopt our scheme number three on plan submitted, on the north side of the creek. Moving the line up the creek, however, about three-quarters of a mile to enable the power house to be located at a position suitable for the final 100 feet head 10,000 h.p. development, the side hill at this elevation being suitable for bringing the concrete canal fairly close to the river, and so shorten the length of the steel penstocks.

Having secured this location we propose that you locate an intake about two miles above the power house to give a head of about 140 feet, and construct a flume having capacity for the development of about 2500 h.p., the initial installation, however, to be as first proposed 1600-2000 h.p. The cost of this flume will be about $16,000 per mile, and the total cost of the plant will therefore be slightly greater than the estimated cost of scheme number one submitted, or about $200,000, and we feel safe in guaranteeing this estimate within ten per cent, something we could not do for construction wor further up the creek.

With the sale of this amount of power obtained at a reasonable cost for development, you would be in the position to make from the start a substantial profit, while should you at once adopt the high head construction you would probably operate at a loss for at least five years.

When the demand for power would exceed the capacity of the lower head system, the city would then be in a financial position to carry out the construction of the high head system, using the permanent construction of a covered concrete lined ditch, with the new intake about 6½ miles above the power house. The greater demand for power would then warrant such construction, and whether concrete lined ditch or timber flume, the final height of the canal for full capacity might be made when the demand appeared for the full development of power, but in the meantime we propose that for from 2500 h.p. to 5000 h.p. you operate both the low and the high head systems, combined to give the power you need.

This is common practice to operate two heads in the same power house from the two systems of penstocks, and in case one intake or system breaks down you have the other as a reserve, and by the time you require the full capacity of the high head system, the low head system shall have paid for itself, and may then be retired without scrapping the power plant or machinery.

In brief, the proposal is first to operate the lower head plant, then the combined low and high head systems, and finally for 10,000 h.p. or more the high head system alone from the upper intake.

The present peak load of your power plant is about 500 h.p. for 5000 people. On this ratio 2000 h.p. should serve about 20,000 people, and 5000 h.p. 50,000 people, and this is about the same ratio of power to population for Vancouver.

The sale of power to industries located near Kamloops will probably be in competition with Adams river power, and hence the necessity of carrying out the initial development of power from the Barrier at the lowest possible cost consistent with sound construction of works, in order that the annual charge per h.p. may be as low as possible, and it is on this analysis of economical operation that we base the above proposals.

We understand that Mr Hermon has proposed the construction of a pipe line system from the high head intake for two miles down the creek to give the initial development of 2000 h.p., then when more power is required he proposes to abandon the power house and plant designed only for this head and costing about $40,000, and to build a new plant two miles further down with further scrapping of plant for the final move of over six miles from the intake. The cost of the pipe for the required capacity is prohibitive, being over $70,000 per mile when placed and covered, for the 8-foot pipe and about $40,000 per mile for the 5-foot pipe —loss of head for the smaller pipe would be over 20 feet per mile.

By the time the six miles system would be completed the two miles of pipe first placed would probably be in decay, and a new pipe line would

be necessary. This fact, together with the prohibitive cost and heavy loss of head places the adoption of such a system, in our opinion, absolutely out of the question, particularly in view of the absurd proposal to practically abandon two power houses with the machinery designed only for a fixed head and two sets of steel penstocks, after an operation of perhaps five or ten years.

The cost of operation under such conditions would be far greater than the operation of the steam plant, and the proposal seems hardly worthy of serious consideration.

The adoption of our scheme number three with the modifications proposed would, we believe, be both economical and safe, comparatively free from uncertain features of construction, and with a covered flume having a large volume of water flowing at a high velocity we believe there would be little or no danger from freezing, although a week, or possibly two weeks of troubles from frazil ice may be expected, but troubles from this source or from sand may be better taken care of with a flume than with a pipe system.

The construction of the plant for the initial development proposed will not involve the same amount of detail surveys, test pits, and careful records of stream flow, rainfall, etc. which will be required in the case of the higher head development for the 10,000 or more horse power.

After the detail surveys are made and plans for the initial development drawn up, the construction of the 1600-2000 h.p. plant could be carried out to completion and power delivered to Kamloops in less than a year.

Respectfully submitted,

Dutcher, Maxwell & Co.

Per H. K. Dutcher.