PRELIMINARY REPORT

ON THE

COMOX VALLEY WATER SUPPLY

THE CORPORATION OF THE
CITY OF COURTENAY
SEP 12
REC'D No.

File: 0215160

August, 1958.

P. J. Leslie, Hydraulic Engineer.

CITY OF COURTENAY

September 4th, 1958

File: 0215160

Mr. A. F. Paget,
Comptroller of Water Rights,
Victoria.

Dear Sir:

The accompanying report entitled "Preliminary Report on the Comox Valley Water Supply" was prepared by Mr. P.J. Leslie, Hydraulic Engineer and is in response to requests made by the City of Courtenay, the Villages of Comox and Cumberland and the Improvement Districts of Arden and Royston. The Atlas of 10 maps under preparation which was to accompany the report is not yet complete. However, pertinent portions of them have been included within the report and the completed sets will be mailed to the above mentioned parties within the next few weeks.

The scope of the investigations in the area has been outlined at several meetings held under the chairmanship of Mr. D. Campbell, M.L.A., and attended by members of the Water Rights Branch.

The report is a preliminary appraisal of water resources in the Comox Valley and includes a prediction of the expected population growth and water consumption which may take place during the next 25 years. On the basis of this data a preliminary layout has been made of the main works which might be operated by a Greater Water Board.

It will be noted that the estimates of cost for the two alternatives (Project A and Project B) were prepared primarily to make a comparison between the two systems and also to provide the organization committee with an approximate measure of the magnitude of such an operation. While the actual evaluation has been only for new works, some of the recently installed pipes of the Royston Improvement District could in part be said to be operating as a main line circuit. However, further analysis was not considered necessary at this stage and would be the subject of a detailed engineering report should planning proceed.

The general conclusions reached in the report would indicate that the area is fortunate in having nearby three sources of gravity water supply. It would appear that the most economical system for future operations would be a combination of gravity water from the B. C. Power Commission dam on the Puntledge River to serve most of the area with a secondary high pressure gravity system from Allen Lake to feed the higher regions around Cumberland.

It is recommended that should the organization committee decide to proceed, that a consulting engineer be retained to prepare a detailed report including plans and estimates.

Yours very truly,

T. A. J. Leach,
Chief Hydraulic Investigations Division

SYNOPSIS

Adequate gravity water to supply the future requirements of a Greater Water District within the Comox Valley including the City of Courtenay, the Villages of Cumberland and Comox and the Improvement Districts of Royston and Arden is available either from the Brown River (Project A) or a combination of the Puntledge River and Allen Lake supplies (Project B).

Requirements based on an anticipated population growth from the present total of 7200 to 18,500 by 1983 show an ultimate consumption at the end of 25 years of 1000 million imperial gallons per annum equivalent to about 3700 acre feet.

Costs of the two alternatives summarized below show that the approximate wholesale price of water to the Greater Water District would range from a low of 11.7¢ per 1000 gallons under Project B to a high of 14.1¢ under Project A. Actual price to the consumer would also include distribution costs which are not covered in this report. Generally the price per 1000 gallons compares reasonably well with the existing wholesale price of water in some of the presently operating Greater Water Districts.

Source	Project "A" Browns River	Project "B" Puntledge River & Allen Lake
Capital Cost	1,801,000	1,434,000
Annual Cost	146,080	116,720
Population 1983	18,500	18,500
Annual Consumption 1983	1,000 m.i.g.	1,000 m.i.g.
Wholesale cost per 1000 gals. .	14.6¢	11.7¢

The estimates do not include an evaluation of existing systems or what portion of them might be charged to main line distribution. Should the organizing committee decide to proceed beyond the preliminary analysis, it is recommended that a consulting engineer be retained to prepare a design report which would include detailed estimates and also the evaluation of existing systems.

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List of References

1. V.A. Gwyther & Co. Report on Corporation of the City of Cumberland Waterworks System. 20th September 1955.

2. V.A. Gwyther & Co. Preliminary Report on Water Possibilities Royston Improvement District. (Report No.1) 30th May 1955.

3. V.A. Gwyther & Co. Water Possibilities of the Royston Improvement District Report No.2. 15 June 1955.

4. V.A. Gwyther & Co. Report on Comparative Costs of water purchased from the City of Courtenay and the City of Cumberland (Report No.3) 12th May 1956.

5. V.A. Gwyther & Co. Preliminary Report. Ground Water Investigations, Village of Comox Area. February 1954.

6. V.A. Gwyther & Co. Report on the Ground Water Supply and its Distribution in the Village of Comox. June 1954.

7. Water Rights Branch Report on Water Supply for Arden Improvement District. May 6th, 1958.

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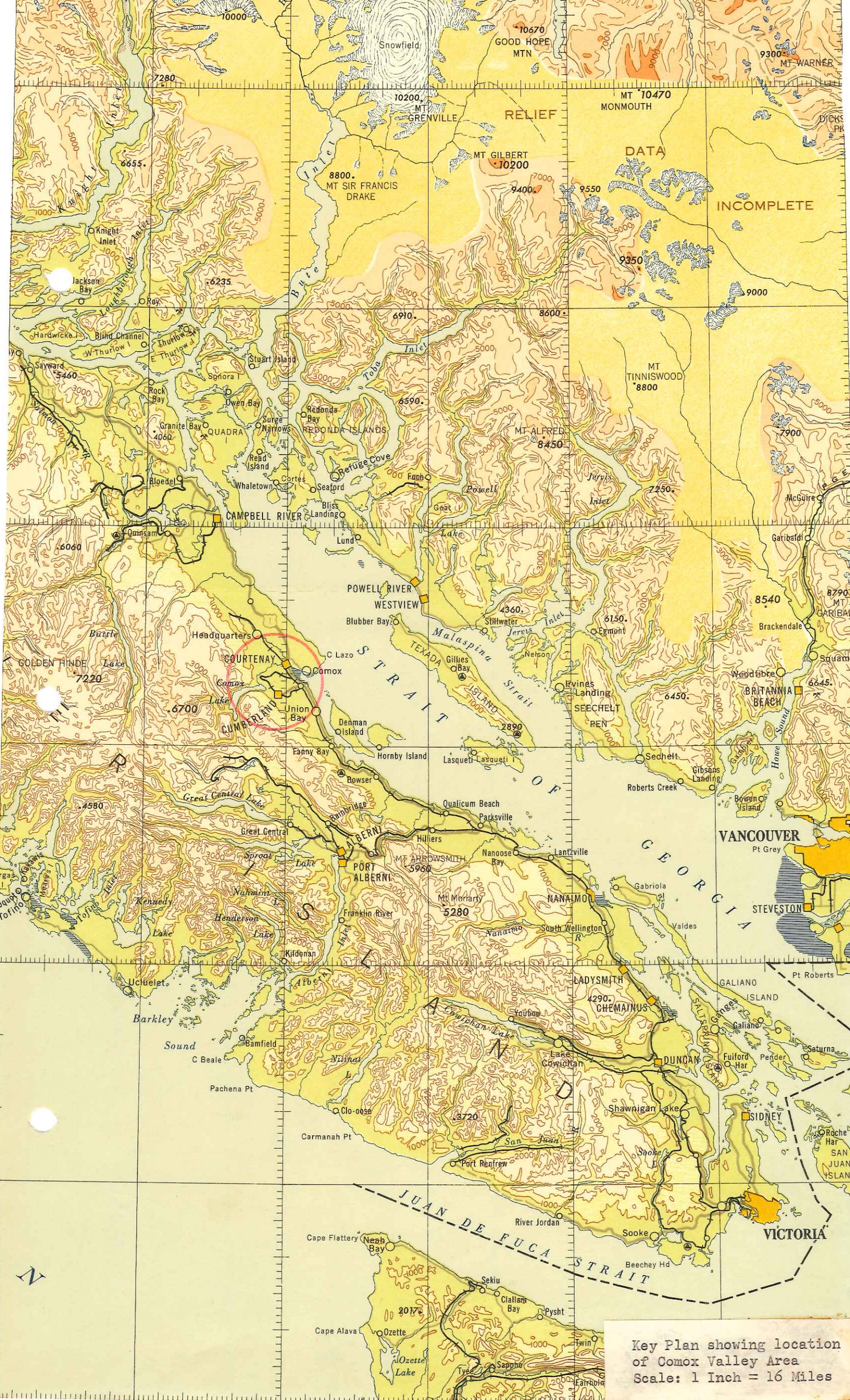


Key Plan showing location of Comox Valley Area
Scale: 1 Inch = 16 Miles

PRELIMINARY REPORT ON THE COMOX VALLEY WATER SUPPLY

Introduction: (See Key Plan)

The Comox Valley area lies on the East Coast of Vancouver Island, approximately 140 miles North of Victoria, and includes the City of Courtenay, the Villages of Cumberland and Comox, and the Improvement Districts of Royston and Arden.

At present these communities, with the exception of Royston (which receives its supply from Cumberland) obtain their water from independent sources, and operate their own waterworks.

While the present systems appear adequate to meet today's needs, future growth in the area will inevitably be coupled with an increase in water requirements, and the resulting necessity for enlargements and modifications to existing waterworks.

As a consequence of this, it has been suggested that a Greater Water Board, supplying water in bulk to the communities within the Comox Valley would prove more advantageous than independent developments. Following several meetings with representatives of the various areas, it was agreed that the Water Rights Branch would prepare a preliminary report dealing with the water resources of the valley and their adequacy with respect to the needs of the growing population.

This report has been prepared with this objective in mind and estimates of cost have been limited to the main structures only, such as storage dams and reservoirs, chlorination units, access roads and main pipe lines. Such costs are ordinarily shared by members of a Water Board while internal distribution lines (which are not included in the report) are the responsibility of the particular areas concerned.

Field Work and Mapping (See Atlas accompanying this report)

Airphoto coverage of the area was flown in May, 1957, and the ground control for planimetric mapping was carried out in July and August, 1957. Map sheets covering an area of some 16 miles by 16 miles to a scale of 1" = 1/4 mile, with 25 ft. contour intervals, were subsequently compiled by the Multiplex Division, and are contained in an Atlas of 10 sheets which accompanies this report.

In the course of the field work, existing water supply schemes were inspected, possible dam and intake sites visited, and information relating to consumption, population trends, distribution system, pressures, etc., was obtained from local authorities.

Present Sources of Supply -

The City of Courtenay. Courtenay draws water from Browns River, which has a catchment area of approx. 34 sq. miles above the point of intake. The intake consists of a low concrete dam across the river, and a concrete intake structure with a single 1/4 inch trash screen.

Water flows from the intake through 1580 ft. of 16" concrete pipe to a concrete settling box, constructed with wooden baffles of the "over and under type". From the settling box the water gravitates through approximately 15,500 ft. of 12" reinforced concrete pipe to an open reinforced concrete service reservoir of 500,000 gals. capacity, located about 1½ miles north west of the City centre. An 18" Reinforced concrete main feeds from the reservoir to the distribution system, which is a "grid iron" layout of 4" to 12" pipes of cast iron and Transite, with a few short sections of wood stave pipe. It is possible to bypass the reservoir through a 12" bypass pipe.

An auxiliary source of supply may be obtained from a 4" connection to the supply main from the 12 ft. diameter penstock of the B. C. Power Commission Power Plant on the Puntledge River. The connection is at the point of crossing of the supply line under the penstock.

Elevations pertinent to the Courtenay system are as follows:

Crest of Dam at Intake	257.2 ft.
T.W.L. Settling Box	254.3 ft.
T.W.L. Service Reservoir	181.1 ft.

At present storage is available in the headwaters of the Browns River at MacKenzie Lakes but this to date has never been used.

The most recent report available (See Appendix A) dealing with the Courtenay Water Supply is that prepared by the British Columbia Underwriters Association in December, 1954.

Village of Cumberland:

Cumberland obtains its supply from a system of lakes and dams lying to the South West of the City. Water is stored in Hamilton Lake and Stevens Lake (combined storage 81,800,000 imp. gallons) which lie at elevations of approximately 1800 ft. and 2030 ft. respectively. The intake is located at what is known as No. 1 dam at elevation 925 feet. Both this dam and No. 2 dam, a short distance upstream, have very limited storage capacity.

Supply to the City is through 9,000 ft. of steel pipe (with one pressure reducing valve). This pipeline and a part of the distribution system have been in service for approximately 50 years, and will require replacement shortly. Extensive logging operations in the watershed area create a danger of pollution of water. The water supply is not chlorinated within the Village. However, at its eastern boundaries it is so treated before entering the Royston system.

Details of the Cumberland Water System and suggested expansion have been dealt with in a report prepared in September, 1955, by Mr. V. A. Gwyther, Consulting Engineer.

Royston Improvement District:

Royston receives water from Cumberland through an 8" transite pipe (installed in 1957) which extends eastward for 6,700 feet from the eastern boundary of the Village to the western limit of the district. The water is metered at the former point. Two pressure regulating valves are employed within the Royston boundaries to reduce pressures. The distribution system is all transite pipe, and has recently been installed. An old connection from Courtenay to the North Royston area is no longer in use. Details of the recently installed Royston water systems are contained in the following reports.

V.A. Gwyther & Co. - Preliminary Report Water Possibilities Royston Improvement District (May 30, 1955)

" " " - Water Possibilities Royston Improvement District Report No. 2 -(June 15, 1955).

" " " - Report No. 3 - Comparative Costs of Water Purchased from the City of Courtenay and the City of Cumberland (May 12, 1956)

Village of Comox

The Comox supply is pumped from two deep wells located within the village boundaries. The maximum combined delivery from the two wells is estimated at 300 U.S. g.p.m. Water from No. 1 well has exhibited objectionable taste and odour, particularly during heavy demand periods,

probably due to the presence of Hydrogen Sulphide.

Storage is contained in a recently constructed wood-stave tank of 200,000 imp. gallon capacity, with a top water level of 232.8 ft.

The distribution system was completely relaid in 1956, and with the exception of two short plastic feeder lines, is all transite piping. The water is not chlorinated, but provision has been made for the installation of a chlorinator.

The most recent engineering reports prepared for Comox are as follows:

V.A. Gwyther & Co. - Preliminary Report Ground Water Investigation, Village of Comox, Feb. 1954.

" " " " - Report on the Ground Water Supply & its Distribution in the Village of Comox, June, 1954.

Arden Improvement District:

The District is not at present served by water, but it is planned to pipe water from springs located near the Courtenay Sand and Gravel Co. pit on the Cumberland Road.

A preliminary report dealing with this area can be found under "Water Supply for Arden Improvement District - May 6th, 1958, W.R.B., by M.L. Zirul".

Population Estimates and Water Consumption (See Appendix B)

Little information regarding water consumption is available for any of the communities, and estimates of future water requirements are based on forecasts of population growth, together with the estimated per capita water consumption.

The growth of the population of the communities in the Comox Valley up until 1956 is shown graphically in Fig. 1, Appendix B, from figures abstracted from the Regional Industrial Index of British Columbia.

Estimates of future population made by the Bureau of Economics and Statistics postulate a maximum average compound rate of growth for the region (Vancouver Island) for the years 1955 to 1980 of 4% per annum, and this figure has been used as the basis for estimating the population growth of Courtenay, Comox and Royston. In view of the slow rate of growth of Cumberland over the period 1941 to 1956, a figure of 2% has been adopted for this centre.

In planning for the future water supply, a period of 25 years was adopted and it will be noted from the graph that at end of this time (1983), a population of 18,500 is anticipated, almost one half of which will be concentrated in the northern area around Courtenay.

Flow measurements taken during July, 1958, for Royston indicated that the average per capita consumption for the month was approximately 125 g.p.d. However, sprinkling regulations were in force during the period, and unrestricted consumption can be expected to exceed this figure considerably. Hourly flow measurements taken over a period of a few days for Cumberland during a previous summer showed a maximum demand rate equivalent to approximately 225 gals. per capita per day.

The following per capita consumption figures have been assumed for the area for estimating purposes:

	Imperial gallons
Annual average consumption	150 g.p.c.d.
Max. daily average consumption (2.5 x Average)	375 g.p.c.d.
Average consumption for summer months	250 g.p.c.d.

Population to be served in 1983 = 18,500

Consumption figures computed on this basis for the communities in 1983 are:

TABLE I (Imperial gallons)

	g.p.c.d.	Courtenay m.g.d.	Cumberland m.g.d.	Royston m.g.d.	Comox m.g.d.	TOTAL m.g.d.
Aver. annual consumption	150	1.31	0.27	0.62	0.56	2.76
Max. daily consumption	375	3.26	0.68	1.56	1.39	6.89
Aver.Cons., Summer months	250	2.18	0.45	1.04	0.93	4.60
Population		8700	1800	4150	3700	18,350

Sources of Supply:

Several engineering reports dating back to 1947 have dealt with sources of supply for certain portions of the overall area..

These are as follows:

E.A. Cleveland - Report to City of Courtenay on Certain Aspects of its Water Supply, October, 1941 - Appendix C.

A.G. Graham - Report on Proposed Diversion of Outlet Creek from Lake Helen MacKenzie, June, 1947 - Appendix D.

F.C. Stewart - Report on Lake Helen MacKenzie Diversion & Browns River watershed with short section on supply and distribution system for City of Courtenay, August, 1947 - Appendix E.

These reports have been included as appendices to provide some background information on the resources of the Valley and to place within one report all the recent observations on the subject.

A number of factors should be considered in determining the most satisfactory source or sources of water. Foremost in this is adequacy of supply during the driest periods such as occurred during the summer of 1958.

The main sources of water within a reasonable distance of the Courtenay-Cumberland-Royston triangle are -

(1) Browns River
(2) Cumberland Creek watershed
(3) Comox Lake & Puntledge River

The first two sources of supply have been partially developed by Courtenay and Cumberland respectively, while electrical energy is produced on the Puntledge River by the B. C. Power Commission. The possibilities of a gravity supply from the Puntledge River which drains the lake will be considered in combination with a pumped supply for the high areas around Cumberland. An alternative to Cumberland pumping would be a gravity supply from Allen Lake.

Yield of Watersheds (See plan No. 3)

Drainage areas of the Brown River and Cumberland Creek watersheds are as follows:

Browns River above present intake	34 sq. miles
Browns River above Medicine Bowl Park	31 sq. miles
Cumberland Creek above No. 1 dam	2.8 sq. miles
Perserverance Creek above Allen Lake	1.0 sq. miles
Total Cumberland and Perseverance Creeks	3.8 sq. miles

No gauging records are available for either Browns River or Cumberland Creek, and estimates of minimum discharges are therefore based on comparison with nearby watersheds for which records exist.

Minimum recorded discharges, average discharges for 100 day periods of minimum flow, and average flows for the driest years for 5 nearby rivers with watersheds subject to similar climatic conditions to those under consideration are given in Table II, together with the assumed design figures to be applied to Browns River and Cumberland watersheds. Included in Table II is an estimate of the flow in Browns River of 2.8 c.f.s. made on August 25, 1958, immediately above the present intake following an unusually dry summer. It is considered unlikely that flows will fall below those assumed.

Storage Requirements (Reference Plan No. 3)

(1) Browns River Watershed

From the minimum flows shown in Table II, a minimum discharge figure of 1.5 c.f.s. for Browns River equivalent to 0.81 m.g.d. was chosen. If this river were to be used as a source of supply for the Valley, whose maximum daily consumption in 1983 is estimated to be 6.89 m.g.d., it is evident that storage will be necessary to augment the flow in Browns River during periods of drought.

The assumed average flow during a dry year is 77.5 c.f.s. or 41.7 m.g.d. Providing sufficient storage is available, the yield of the watershed will be more than adequate to meet the estimated future requirements.

Basing storage requirements on a 100-day period of drought, an average summer use of 4.60 m.g.d. and 100 day dry flow of 4.65 c.f.s. (2.50 m.g.d.) , the following storage is required (assuming no losses):

$$(4.60 - 2.50) \times 100 \text{ m.g. (Imp)}$$

$$= 2.10 \text{ m.g. (Imp)}$$

$$= 775 \text{ acre feet.}$$

Assuming an arbitrary loss of water of 40% between the storage lakes and the point of intake, including evaporation, the storage requirements would be 1290 acre feet.

TABLE 11

Minimum and Average Discharges of some coastal streams on Vancouver Island near Courtenay

	Campbell River at Lake	Stamp River above Falls	Puntledge River above Dam	Big Qualicum near mouth at E. & N. Rly. Bridge	Little Qualicum at Outlet Cameron Lake	Browns River at Courtenay Intake	Browns River at Medicine Bowl	Cumberland Creek at Dam No. 1 Plus Allen Lake
Period of Record	May,1910 to Aug.1949	June,1914 - June,1931 Feb.1941 - present.	Jan.1914 to present	Mar. 1913 to Sept. 1922	Feb. 1913 to Sept. 1922	Nil	Nil	Nil
Drainage Area (square miles)	542	336	175	62	54	34	31	3.8
Minimum Discharge (cubic feet/sec)	280	88	180	15	28	2.8	1.5	0.19
Minimum Discharge (c.f.s./sq. mile)	0.52	0.26	1.03	0.24	0.52	0.08	0.05	0.05
Date of Minimum Discharge	Sept.1926	Aug.1941	Sept.- Oct.1915		Sept.1915	Aug. 25 1958	--	--
Minimum Average Discharge for 100-day period (c.f.s.)	870	252	250		41	465	0.57	
Minimum Average Discharge per square mile for 100-day period (c.f.s.)	160	0.75	1.43		0.76		0.15	0.15
Date of 100-day Minimum Flow	July 1st to Oct. 8, 1926	July 1st- Oct. 8th, 1941	July 9 - Oct. 16, 1915		July 1st - Oct. 8th, 1915			
Average flow for driest year (c.f.s)	2510	2630	984		242		77.5	9.5
Discharge per square mile - driest year (c.f.s.)	4.63	7.83	5.63		4.48		2.5	2.5
Year of driest flow	1926	1941	1915		1915			

No suitable storage site exists on Browns River, but storage may be developed at its headwaters on the group of lakes lying on the Forbidden Plateau, which drain to, and through Pearse Lake into Browns River. Storage in these lakes could be secured either by raising the level of the lakes by means of small dams at the lake outlet, or by drawing off water by trenching into the lakes. Outlet conditions at each lake would dictate the most suitable method to be employed.

Eight feet of storage is already available in McKenzie Lake, which was raised in 1931 by the construction of a log dam at the lake outlet. A further 10 feet of storage could be impounded by constructing a higher dam immediately below the existing dam. (See Plan No. 4). This would result in the inundation of Douglas Lake, which is about 5 feet higher than the present elevation of McKenzie Lake. A trench between Douglas Lake and McKenzie Lake would make available approximately 4 feet of storage in Douglas Lake, when McKenzie Lake was drawn down below the present elevation of Douglas Lake.

TABLE III

Lake	Drainage Area - sq. mi.	Total Run-off day year ac.ft.	Surface area acres	Depth of Storage feet.	Volume stored ac.ft.
McKenzie	2.3	4160	36.5	18	666
Douglas			19.5	4 & 5	175
Johnson	0.5	905	30.8	8	246
Netuts	3.0	452 (excluding overflow from Johnson L)	15.7	5	78
Pearse	7.1	235 (excluding overflow from other lakes)	31.4	8	251
TOTAL	7.1	12,850			

Considerable additional storage (approximately 1200 acre feet) could be made available on Helen MacKenzie Lake. This lake drains naturally to the Oyster River, but water from the lake could be diverted to Browns River by means of a diversion ditch of approximately one mile in length. However, this scheme would probably prove costly, and would only need be implemented after development of the other storage lakes, and should conditions require it. (See F. C. Stuart's Report in Appendix E).

2. Cumberland and Perseverance Creek Watersheds

The Cumberland Creek watershed above Dam No. 1, together with the Perseverance Creek watershed draining into Allen Lake covers an area of 3.8 square miles, or about one-ninth that of the Browns River watershed above the Courtenay intake. (The drainage areas of both the Browns River and Cumberland-Perseverance Creeks watersheds are outlined in the topographical may contained in this report).

A dry year run-off of 2.5 c.f.s. per square miles (or 1810 acre-feet per square mile per annum) was assumed for the Browns River watershed. The average elevation of the Forbidden Plateau from which most of the Browns River run-off originates lies at an elevation of about 3500 feet, compared to an elevation of approximately 2000 feet for most of the Cumberland-Perseverance Creeks watershed. It is probable that the dry year flow per square mile for the Cumberland-Perseverance Creeks areas would be less than the corresponding figure for the Forbidden Plateau area since the former lies some 1500 feet lower in elevation. However, using the same figure, the following dry year run-off might be expected.

3.8 sq. miles x 2.5 c.f.s. = 9.5 c.f.s.

= 5.1 m.g.d. (imp)

The required storage in 1983 for a 100-day period, assuming no losses, would be

(4.60 - 0.31) x 100 = 429 m.g. (imp)

= 1580 acre feet.

Allowing for a 15% loss from seepage and transportation, plus a further 100 acre-feet loss over the period from evaporation (based on a total lake surface area of 100 acres and evaporation loss of 3 inches per month or 12" per 3 months), the required storage becomes 1960 acre feet.

Mr. V. Gwyther, in his report entitled "Corporation of City of Cumberland Waterworks System" (Sept. 20th, 1955) lists the following storages.

Location	Storage (Millions of Imp. gallons)	Acre Feet
1. Reservoir No. 1 (Intake)	nil	nil
2. Reservoir No. 2 (Maximum)	16.0	59.0
3. Reservoir No. 3 (Maximum) (Hamilton L)	45.2	167.0
4. Reservoir No. 4 (8' Higher elev.) (Stevens L)	71.3	264.0
5. Reservoir No. 5 (proposed max.) (Henderson L)	107.0	396.0
6. Reservoir No. 6 (10' higher) (Allen Lake)	62.0	230.0
TOTAL	301.5	1116.0

The total storage of 1116 acre feet still leaves a deficit of 844 ac. ft.

It is understood that a report just completed by Mr. V. Gwyther discusses the possibility of raising Allen Lake some 55 feet. Water would be diverted from Cumberland Creek into this large reservoir, and a new 12" main would be laid from Allen Lake to the centre of Cumberland.

Further storage could be obtained in Tsable and Poum Lakes which have a combined drainage area of 2.75 square miles. These lakes drain naturally to the Tsable River, but could be diverted to the Cumberland watershed. However, the diversion would be approximately 7 miles in length across rough terrain, and would in all probability prove unfeasible on economic grounds.

In view of the deficit in storage, the marginal surplus yield of the watershed over the demand during a dry year, and the danger of pollution in the watershed area, it is not recommended that the Cumberland watershed be considered as a source of supply for a Greater Water Board for the Comox Valley.

PROJECT "A" - Gravity supply from Browns River
(Reference Plan No. 1)

Source of Supply and Intake

A suitable source of supply for the area served by a Greater Water Board would be Browns River, by virtue of its large catchment area, adequate storage potential within the watershed, its proximity to that part of the area where expansion is taking place most rapidly, and where the greatest concentration of population may be expected to occur, and under present conditions, the relative freedom from danger of pollution of its water. Some disadvantage at present lies in the difficulty in reaching the Plateau Lakes, and it would be necessary to construct access roads to the reservoirs.

In order to supply water to all areas by gravity, it would be necessary to resite the intake on Browns River at a higher elevation. A suitable site for a small dam and intake exists at Medicine Bowl Park some 2¼ miles above the present intake. The top water level of a dam at this site would be approximately 755 feet and local storage of about 4 m.g. would be created upstream of the dam. (See Plan No. 6). This storage would be extremely useful for regulation purposes, to prevent wastage when stored waters from the Plateau Lakes are released into Browns River, and would also provide a valuable balancing effect on fluctuating demands over short periods. In the design of the dam, the possibility of sand, gravel, and boulders moving downstream and accumulating behind the dam should be borne in mind and adequate flushing facilities would be necessary.

Storage

Storage would be obtained in lakes on the Forbidden Plateau, and has already been discussed under "Storage Requirements". Development of storage would be in stages as the need arose. (See also Reports by Cleveland (Appendix C) Graham (Appendix D) and Stewart (Appendix E) appended to this report).

It will be noted in Appendix F and also Table III that headwater storage has been planned at the following sites:

Lake	Storage Volume A.F.	Total Cost	Cost per ac.ft.
McKenzie and Douglas	841	$ 21,000	$25.00
Pearse	251	2,000	8.00
Netuts	78	2,000	25.00
Johnson	246	9,000	36.60
Total	1416	34,000	

The cost per acre foot of storage in the reservoirs varies from a low of $8.00 per acre foot at Pearse Lake to $36.60 for Johnson Lake. With the exception of Pearse and Netuts Lakes, all reservoirs require dams and clearing, and this latter item makes up more than 50% of the total cost.

Storage on Pearse and Netuts Lakes are obtained by lowering the outlets and placing small control gates in them.

Adequate access roads to the storage sites totalling some 12 miles would be needed to allow reservoir operations during the critical dry periods of the summer, and also for maintenance and repair.

Layout of Pipe Mains. (Reference Plan No. 1.)

A 24" steel trunk main would be required from the intake dam to a point near the existing Courtenay service reservoir. From this point small branch lines would feed to the existing and proposed Courtenay service reservoir located near Cumberland. For the purposes of design, Royston has been divided into high level and low level zones, being respectively that area along the Cumberland Road lying above the E. & N. Railway line, and that area along the Island Highway, lying below the E. & N. Railway line. The high level zone would be supplied from the service reservoir near Cumberland, which would also supply Cumberland, and the low level zone would be supplied from the Courtenay reservoir.

A further 12" main would feed to the Comox Service reservoir, which would supply Comox and other consumers in the area.

A 6" branch from the 16" main to Cumberland would supply Arden Improvement District.

The layout of the system is shown on the 1/4 mile to 1 inch map sheets in the Appendix, and estimated costs are shown in Appendix F.

Service Reservoirs

The function of service reservoirs is to equalize supply and demand over short periods, making possible a reduction in the size of main supplying the centre, and also to prevent the interruption of service due to breaks in the main between the service reservoir and intake. A reserve of water for fire fighting purposes is also provided.

The possible location of service reservoirs is indicated on the 1/4 inch to 1 mile map sheets on Plan 1. Suggested eventual storage capacities are as follows:

Location	Area Supplied	Capacity
Courtenay	Courtenay and low level zone of Royston	1 m.g. (in addition to existing ½ m.g.)
Cumberland	Cumberland & high level zone, Royston	½ m.g.
Comox	Comox and neighbouring consumers	½ m.g.

PROJECT "B" - Gravity supply from Puntledge River and a second gravity supply from Allen Lake

(Reference Plan 2)

At present the B.C. Power Commission is generating electrical energy through the diversion of water on the Puntledge River where a headwater elevation of 422 feet is maintained. It would be possible to construct an intake at the diversion dam site which would feed water through a 24" pipe to the same general system outlined in Project A and shown on Plan 2. The approximate top water level of Courtenay service reservoir which the 24" line would feed would be 390 feet which would service all areas below elevation 300 feet. It will be noted on the map that this would cover all the land east of the power line or about 80% of the predicted built-up sections.

A second high pressure supply would be needed to feed the Cumberland region and other high areas west of the power line which could be provided by one of three alternatives, namely:

(a) Pumping from Comox Lake (elevation 440 feet) to a high pressure (elevation 650 feet) one million gallon reservoir at Cumberland. This would involve about an 80 h.p. installation on the lake and some 9900 feet of 12" pressure line.

(b) Booster pump to be installed on the main leading to Cumberland which would require 110 h.p. and would also include the service reservoir.

(c) Use of Allen Lake storage feeding through a 12" line into the Cumberland system.

The latter would require about 2,000 feet less pipe than alternative (a) and would eliminate the need for a large service reservoir and pump. It has similar advantages over the booster pump scheme proposed under (b).

Allen Lake storage would also eliminate the annual pumping costs because even with its limited drainage area (1.0 square miles), some 1,000 to 1,200 acre feet of storage might be realized by the construction of an adequate dam.

For these reasons the cost of Project "B" has been estimated on the basis of two gravity supplies; one from the B. C. Power Commission diversion dam on the Puntledge River and to feed areas below 300 feet elevation and a second smaller supply from Allen Lake for elevations between 300 feet and 600 feet. These two systems would, of course, be interconnected as shown on Plan 2.

In making the estimate shown under Appendix G. it should be noted that we have assumed a development of 1,000 acre feet of storage on Allen Lake which would require about a 5-foot dam. With the limited drainage area tributary to the lake this is probably its maximum development unless other waters can be diverted into it. As previously mentioned we understand that Mr. Gwyther will be reporting to Cumberland regarding possible diversions to Allen Lake.

Cost Comparison Between Projects "A" and "B"

In comparing the capital cost of Project "B" with that of "A", it will be noted that a reduction of $299,000 has been realized in "B". The major portion of this decrease in cost has been through a reduction in the length of the 24" intake main from 29,400 feet under Project "A" to 17,900 feet under Project "B". Again, whereas some $70,000 was required for storage and access roads in the Forbidden Plateau region, this has now been reduced to the comparable figure of $25,000 for the Allen Lake storage. These differences in capital cost are reflected in the annual operating expenses as shown below.

	Project "A"	Project "B"
Source	Browns River	Puntledge River & Allen Lake
Capital Cost	1,801,000	1,434,000
Annual Cost	146,080	116,720
Population 1983	18,500	18,500
Annual Consumption 1983	1,000 m.i.g.	1,000 m.i.g.
Wholesale cost per 1,000 gals.	14.6¢	11.7¢

The annual costs above have been arrived at on the basis of 5% interest and retirement of capital in 25 years. An additional 1% has been added for operation and maintenance and $2,000 for chlorination.

It will be realized that the estimates in this report are very approximate and only cover what might be considered as the mainline system. Further to this, no attempt has been made to price other than steel pipe and substantial savings may be realized by the use of other materials. The prices therefore quoted above are used more in a comparative manner to evaluate one project against the other.

Bearing these limitations in mind, it will be noted that the cost per 1,000 gallons in 1983 varies from 11.7¢ for Project "B" against 14.6¢ for Project "A".

However, no allowance has been made under Project "B" for any annual charges by the B. C. Power Commission for the diversion of domestic water from the Puntledge Plant which, in 1983, would average 2.76 million imperial gallons a day equivalent to about 5 c.f.s.

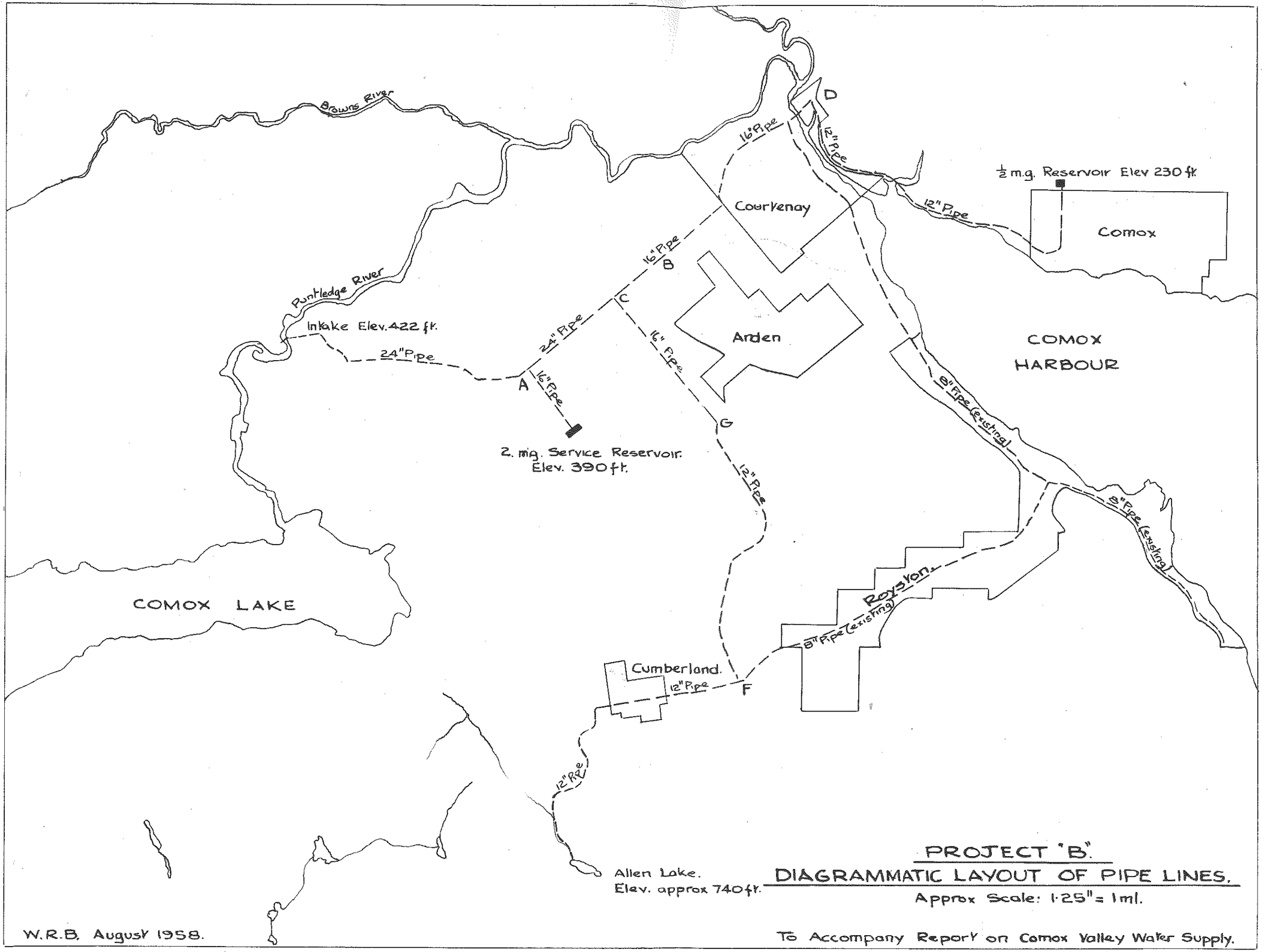
CONCLUSIONS AND RECOMMENDATIONS

(1) It is predicted that in the next 25 years the Courtenay, Comox, Cumberland, Royston, Arden areas on Vancouver Island will increase in total population from 7,200 in 1958 to 18,500 in 1983.

(2) By 1983 this population will require 1,000 million imperial gallons of water per annum. About 65% of this consumption will be in the Courtenay-Comox area, 22% in the Royston and Arden regions and the remainder in the south-west region around Cumberland.

(3) While adequate water is available through storage at the headwaters of the Browns River to supply this demand, the proximity of the Puntledge River and the existing diversion dam on it would provide the cheapest source providing arrangements can be made with the Power Commission. A second higher gravity supply from Allen Lake would be required to serve Cumberland and the south west regions.

(4) This report is primarily to provide the organization committee with a preliminary appraisal of water resource availability and approximate costs. It is recommended that should they decide to proceed further, that a consulting engineer be retained to prepare a detailed report including plans and estimates.



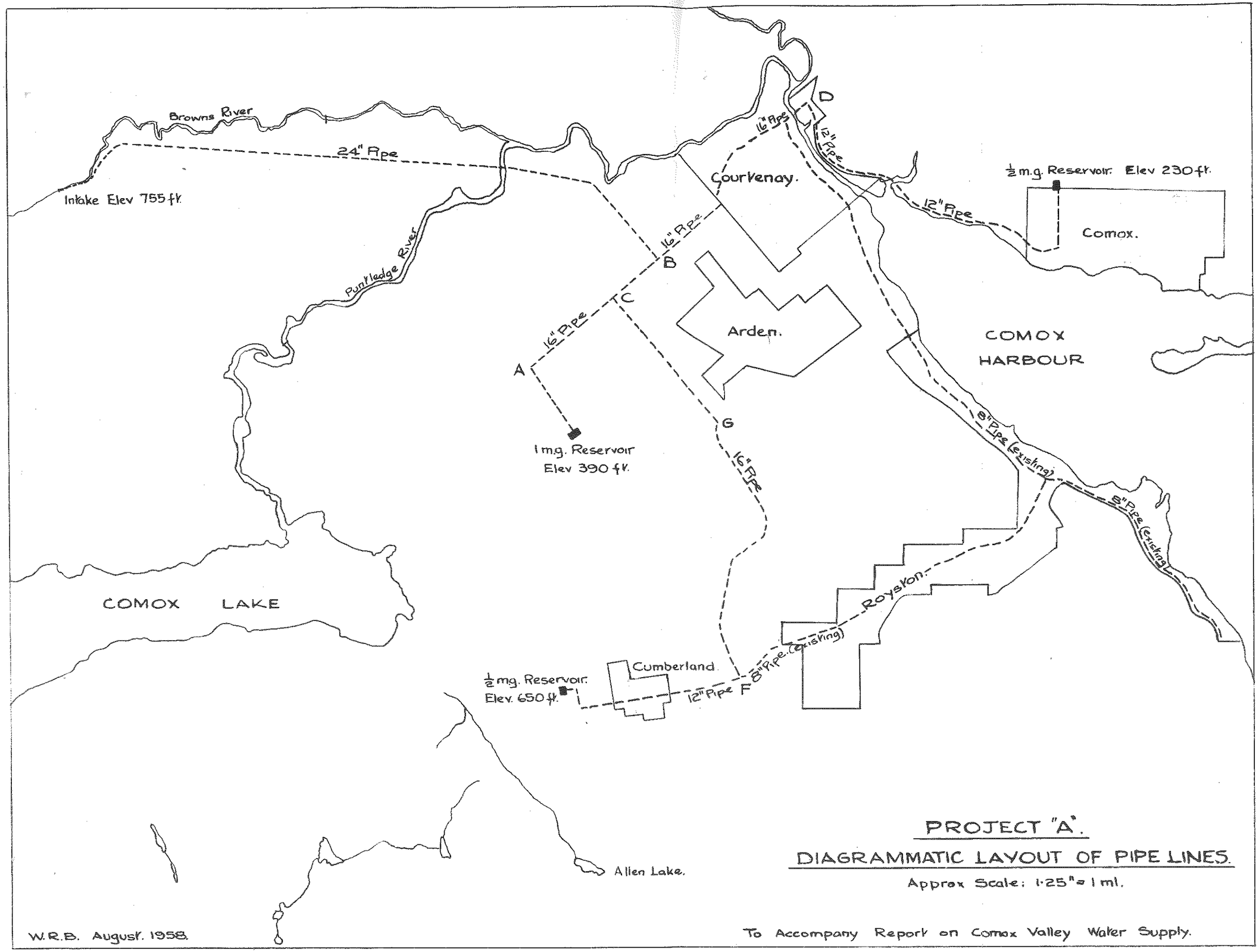
PROJECT "B".

DIAGRAMMATIC LAYOUT OF PIPE LINES.

Approx Scale: 1·25" = 1 ml.

W.R.B. August 1958.

To Accompany Report on Comox Valley Water Supply.



PROJECT "A".

DIAGRAMMATIC LAYOUT OF PIPE LINES.

Approx Scale: 1·25" = 1 ml.

W.R.B. August. 1958

To Accompany Report on Comox Valley Water Supply.

Excerpt from British Columbia
Underwriter's Assoc.

REPORT ON THE CITY OF COURTENAY, B.C. December, 1954.

CITY IN GENERAL

The city is incorporated, population as given in the 1951 census was 2553, but is now estimated to be about 3000. Administration is by a mayor and six alderman. It is the centre of a farming, logging and lumbering district. Industries are mainly dairying, small manufacturing and repairs and distribution. Location is on the east side of Vancouver Island about 140 miles north of Victoria, B.C. Transportation is provided by the Esquimalt and Nanaimo Railway and Provincial Island Highway and an air landing field within five miles. Topography is fairly level. Elevation of the main mercantile is about 40 feet. The area is 840 acres. Street widths in mercantile district are 60 feet wide with one 40 feet wide with 20 foot lanes in part. There are 19 miles of street of which 5 miles, including the Provincial Highway, are paved; the remainder being gravelled and in good condition. The climate is mild with temperatures ranging from an absolute low of -6 in winter to high of 90 in summer. The average annual precipitation is 54.36 inches.

The fire loss for the five years from 1949 to 1953 inclusive was $23,396.00 which based on a population of 2550 represents an annual per capita fire loss of $1.84.

FIRE FIGHTING FACILITIES
WATERWORKS.

Note: Gallons where mentioned are in Imperial measure. Elevations are given in feet above sea level.

OWNERSHIP: The city owns and operates the system. The system was installed in 1921 under the supervision of a consulting engineer. There has been a considerable renewal of all pipe lines since. There are no detailed plans available.

ORGANIZATION: Mr. H. Sims is acting as supervisor. There is a city foreman in charge of maintenance and repairs with two permanent service men and others as required. Maintenance of the sytem appears to be good. A consulting engineer is retained for construction and extensions.

RECORDS: There are no detailed plans of the waterworks system. Details given on the enclosed plan were compiled from information given from memory.

QUARTERS: There is a work shop on 6th Avenue adjoining the fire hall. It is a one storey frame building with one bay for storage of a truck. There are also two sheds on a lot at the corner of Cumberland Road and Piercey Avenue. A start has been made on the construction of new works quarters at the latter location. A few replacement valves, dydrants and pipes are kept in stock.

FIRE SERVICE AND EMERGENCY OPERATIONS: There is no arrangement for waterworks employees to attend fire alarms but they are available on call.

SUPPLY WORKS: The primary source of supply is the Brown's River from an intake about 5½ miles from the city. The area of the watershed is about 33 square. It is not fenced and is accessible to the public and is being logged at the present time. The intake consists of a concrete dam with a concrete intake equipped with a single ¼ inch trash screen. Difficulty is had keeping the screen clean due to gravel being piled against it by freshets. There is a flush-out gate in the dam which was choked with gravel from recent freshets. The elevation of the intake is 254 feet.

A secondary supply may be obtained by opening a gate in a 4-inch connection to the 12-foot diameter penstock of the B.C. Power Commissions power plant on the Puntledge River. This connection is made at the location of the crossing of the penstock over the supply line at an elevation of 194 feet. It was not available for use at the time of making this inspection but it is expected to be available when the penstock is watered early in 1955.

There is no record of the supply from Brown's River failing but it became so low a few years ago that it was necessary to sandbag the dam to retard seepage. In the event of failure of the Brown's River it is possible to open a spillway in a dam holding the water in MacKenzie and Pearse Lakes at a higher elevation in the watershed.

CONSUMPTION: There are no records of consumption. Based on an average daily per capita of 100 gallons it is estimated the city uses 300,000 gallons with a probable consumption of an additional 100,000 gallons by connections furnished neighboring communities. It is reported that there has been no shortage of water for many years.

METERS AND SERVICES: There are no meters in the city except for mercantiles. There are 950 water services in the city. There are 4-inch supply mains to Royston, Comox, and the Campbell River Road.

SUPPLY MAINS: The main from the intake to a concrete settling box is 16-inch reinforced concrete for about 1580 feet. From the settling box to the reservoir it is mainly 12-inch reinforced concrete. Where crossing the Puntledge River the pipe is steel with concrete reinforcing and is buried under the river. Where crossing under the penstock for the B.C. Power Commission it is steel. The total length from the intake to the reservoir is about 16,500 feet. From the reservoir the supply pipe is 18-inch reinforced concrete. There is a 12-inch by-pass normally kept closed around the reservoir. The pipe line is covered 3 feet and more throughout its length.

RESERVOIR: The reservoir is an open reinforced concrete lined basin with a capacity of 500,000 gallons located at an elevation of 180 feet about 5100 feet south west of thecity limits. It is kept filled by regulating the flow from the 12-inch supply line and an overflow drain.

DISTRIBUTION SYSTEM: Consists of gridiron system of 4-inch to 12-inch mains supplied by the 18-inch main mentioned above. There is a loop of 12-inch mainly cast iron mains with a short section of wood stave main serving the business district.

PIPE: The main distribution pipes are cast iron for the most part. The minor distributors are cast iron, transite and wood stave. The wood stave is old and gradually being replaced with transite. Pipes are buried 3 to 4 feet. The following is a list of 4-inch and larger pipe in the distribution system. It is scaled from a waterworks plan as outlined to use by the supervisor and is only approximate.

(Cont'd)

Pipe in the Distribution System - November, 1954.

Size in Inches	LENGTH IN FEET C. Iron	Transite	W. Stave	% of Total	% in Dead Ends.
12	9,840	2,900	2,400	25.5	
10					
8	3,350			5.7	
6	16,810		1,250	31.4	18
4	1,050		21,050	37,7	16
TOTALS		58,650		100.0	34

GATE VALVES: There are valves on the supply main at the intake, at the logging road crossing, at the crossing of the Puntledge River, two where passing under the penstock, three at the reservoir and one at the connection to the distribtion system at the city limits. On the distribution system there is a fair distribution of valves at all junctions in the gridwork. All valves are unidirectional in operation. They are of the single wedge hub type, made by Crane and Terminal City Ironworks. Valves on the supply are in concrete pits except two at the penstock are partly buried. On the distributor system the valves are reached through mainly cast iron stem boxes with cast iron covers. Not all valves are readily accessible, some having been covered over by road construction.

HYDRANTS: There are 68 hydrants of the two-way-post type half with engine connection. All have 6-inch barrels. Laterals are mainly valved. Diinently marked on the cap. Operating spindle and nut are of uniform size and shape. All are of Terminal City Ironworks make. Hose threads are $7\frac{1}{2}$ to the inch, 3 1*16th outside diameter. Hose threads are expected to be converted to fit the B.C. standard early in 1955. Hydrants are mainly located at street intersections. There are some hydrants supplied by 4-inch laterals but these are gradually being changed to 6-inch. Hydrants used in tests operated satisfactorily except one had a seized stem. Hydrants drain properly to gravel beds.

FIRE FLOW TEST: SEE PAGE 4.

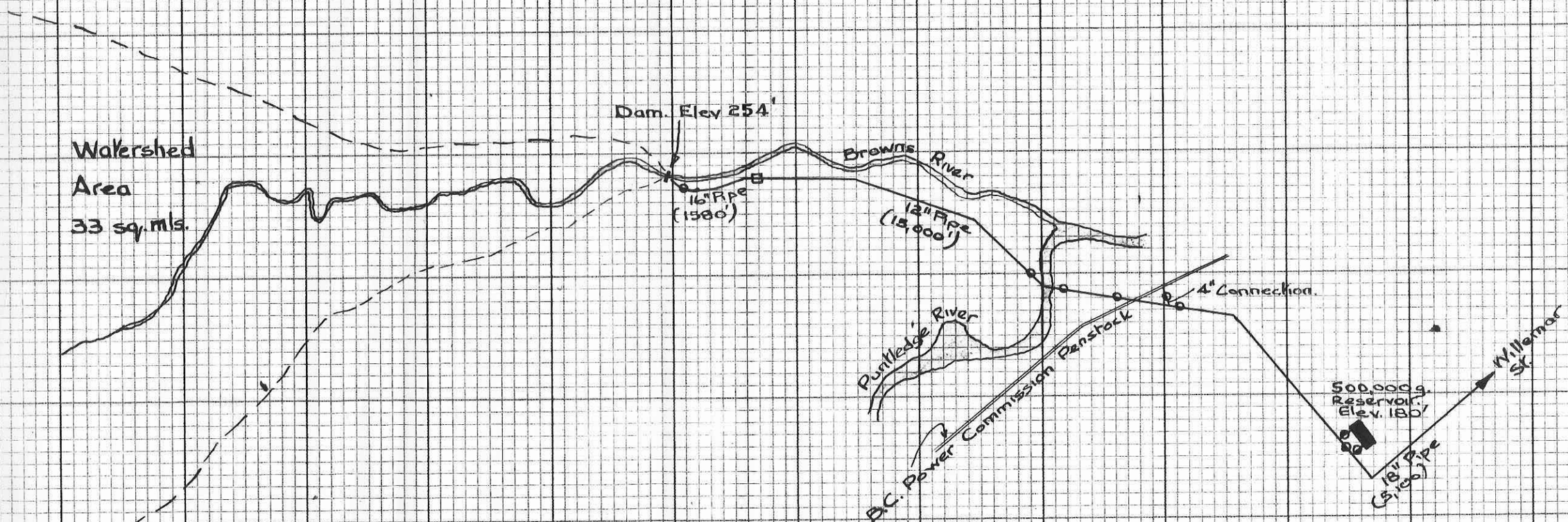
CONCLUSIONS: The waterworks system is under fair management. The primary supply is ample; storage is fair. The gridiron distributing system is fair but there is weakness in some districts from small mains. The entire system is vulnerable to a break in the supply line from the reservoir. The management is progressive inasmuch as good engineering is retained and there is a program for progressive replacement of wood mains and all mains under 6-inch diameter.

FIRE FLOW TEST.

The following table indicates results obtained on a cool day in December, with domestic consumption assumed to be normal.

DISTRICT	NUMBER AND LOCATION	Pressure, P.S.I. Hydrants Closed	Pressure, P.S.I. Hydrants Open	DISCHARGE G.P.M.	QUANTITY REQUIRED	QUANTITY AVAILABLE at 60 l b'	QUANTITY AVAILABLE at 20 l b.
High value	1. Cliffe & 5th St.	56	48	1503	2000	-	3200
Industrial	2. Comox Rd. & 5th St.	67	54	766	2000	-	1450
Industrial	3. Comox Rd. & Sawmill	66	4	233	1500	-	200
Residential	4. Fliffe & 20th	62	55	866	600	-	2100
School	5. England & 8th Ave.	45	42	503	1500	-	1440
Residential	6. Piercy Ave. & Cumberland Rd.	35	33	702	1000	-	1900
Residential	7. Lewis Ave & 19th Ave,	45	5	233	600	-	185
Residential	8. Pidcock Ave. & 2nd St.	38	19	502	600	-	500
Residential	9. England Ave. & 3rd St.	52	19	441	600	-	445

FIRE FLOW TEST.

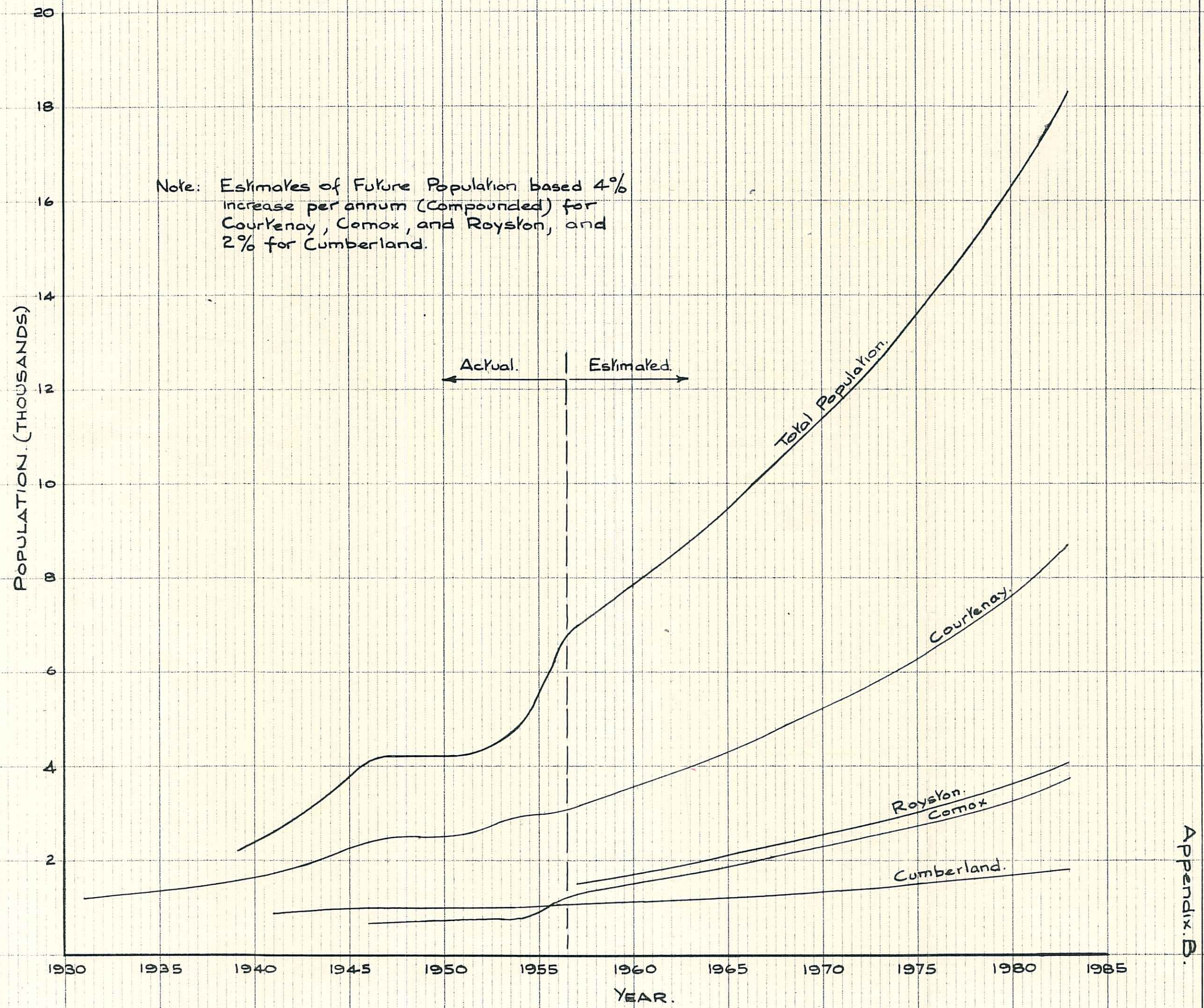


SKETCH PLAN OF COURTENAY
WATER SUPPLY SCHEME.

Approx. Scale 1 inch = ½ ml.

B'

Note: Estimates of Future Population based 4% increase per annum (Compounded) for Courtenay, Comox, and Royston, and 2% for Cumberland.



Appendix B.

POPULATION FORECAST FOR COMOX VALLEY AREA.

W.R.B. August 1958.

To Accompany Report on Comox Valley Water Supply.

REPORT TO

CITY OF COURTENAY

ON

CERTAIN ASPECTS OF ITS

WATER SUPPLY SYSTEM.

To:
The Mayor and Members of the
City Council

E.A. Cleveland
Vancouver, B.C.
October 8th, 1941.

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INDEX TO APPENDICES

The Mayor
and Members of the City Council
Courtenay, B.C.

Sirs:

Your letter of April 23rd last, directed to the Secretary of my Board, advised that Mr. A.G. Graham, City Engineer of Nanaimo, had made a very thorough investigation of your water supply system from Brown's River and had given you a very comprehensive report with full details of costs in regard to obtaining both for the City of Courtenay and Districts an adequate future water supply.

You asked if I could pay you a visit and look over the situation to make sure you "were making no mistake in regard to the suggested alterations and new construction."

I, accordingly, made a visit to Courtenay on April 27th to 29th and with the kind assistance of your officials made a general inspection of the whole situation and was afforded the opportunity of perusing Mr. Graham's report and plans and of having an informal discussion with yourselves,

From observations made in the report and from information gathered from your Water Officials, it became quite clear that the lowest flows of Brown's River in the summer season passing your present intake works would not provide for greatly increased deliveries of water to meet the demands of the City and adjacent territory should their growth continue for some years on an accelerated scale.

The first question, therefore, that presented itself for consideration was as to the adequacy of Brown's River to permanently meet these demands. This involved the question of whether artificial storage of water could be created on the main stream or in the several lakes at its source in the Forbidden Plateau.

Your officials advised me that the small log dam built by the City at the outlet of McKenzie Lake in 1931 and which raised the lake surface approximately 8 feet for storage purposes had at no time in the ten years' interval been required to be opened to let down storage water.

A study of the excellent topographical map of the region prepared by the Provincial Department of Lands, a copy of which is attached hereto, discloses no storage site of any suitable proportions on the River itself from the intake dam to the Plateau. This is confirmed by the opinion of those who know the River over that difficult stretch.

Subject to the adequacy of the River as a source of water supply being later confirmed by further examination, I advised you at our discussion that I could not share Mr. Graham's view as to the desirability or the necessity of moving the intake upstream entailing an increase in the length of the supply main.

Subsequently I had the opportunity of discussing the matter with Mr. Graham.

As the Plateau investigation could be suitably carried out only in the summer it was arranged that I should come over later. Accordingly I made a visit to that area during the second week in August.

Upon return from that investigation I wrote you under date of August 11th setting out in brief the results of the visit which are amplified herein.

WATER STORAGE

The examination of the lakes in the watershed convinced me that considerable storage may be made available in the several lakes as shown on the map attached, viz. Lady, Johnson, Douglas, and Pearse, in addition to the storage the City at present has developed in McKenzie Lake. Netuts Lake was not visited and although Battleship Lake was visited its outlet was, for lack of time, not examined. From the observations made it is clear that enough storage can be created at these lakes to greatly increase the flow of Brown's River at the City intake during the period of low summer flow. This storage would be created by the construction at the outlets of the various lakes, when and as required, of small wooden dams, since that is the most economical type of structure in such places, or by narrow trenches in the solid rock or partly by one and partly by the other method. Some hurried

notes as to each of the outlets visited will be found in the Appendix to this report.

The lakes are listed hereunder with the present surface area of each as taken from the manuscript map of the region in the Surveys Branch of the Provincial Department of Lands.

The areas of the lakes in question are as follows:

1.	Lady Lake	33.6 acres	Assume	6'	storage	= 201	acre feet
2.	Johnson Lake	30.4 "	"	8'	"	= 243	" "
3.	Netuts Lake	16.8 "	"	5'	"	= 80	" "
4.	Douglas Lake	20.0 "	"	4'	"	= 80	" "
5.	McKenzie Lake	27.2 "	"	8'	"	= 216	" "
6.	Pearse Lake	24.0 "	"	8'	"	= 192	" "
		152.0 "				1,012	acre-feet
	Battleship Lake	32.8 "		?		?	
	Croteau Lake	8.0 "		0		0	

As observed elsewhere in the report I did not have an opportunity of visiting the outlet of Battleship Lake and its area therefore has not been considered in the computation. It may have equally good facilities as the others for a dam or trench at its outlet.

On account of the small area of Croteau Lake and its beauty and the extensive tourist camp developed there it is not a suitable site for storage.

McKenzie Lake is already developed at your future experience with the use of water from this lake will indicate the appropriate time for constructing the other storage works referred to later.

From lakes 1 to 6, as tabulated, 1000 acre-feet of storage can be quite readily and cheaply obtained.

This quantity of stored water will provide 5 cubic feet of water per second, equivalent to approximately 2½ million gallons per day for 100 days during the summer period. Some part of this water may not reach the City intake on Brown's River in a very dry year but it is safe to say that 1½ million gallons per day should reach the intake in any event.

At some convenient time the outlet of Battleship Lake should be

examined. If it is as well suited as the other lakes for storage the total available from this group of lakes might be increased by 25%.

It will be noted from the map that the water of all these lakes, which lie at altitudes of from 3,000 feet to 3,900 feet above sea level, passes through Pearse Lake.

The required discharge of storage water into Brown's River would be quite simply effected through the control at the outlet of this lake. This is to say all the storage water required from day to day would be taken from Pearse Lake until its available storage was largely used when water from one or more of the lakes upstream would be drawn to refill it.

The drainage area of each lake is amply capable of producing the storage water required. These areas are shown on the map and the total catchment area of Brown's River is indicated as nearly as may be by a red line. This area is approximately 15,300 acres or about 24 square miles. Storage rights on these lakes should be obtained.

I also visited Helen McKenzie Lake, the water from which flows toward Oyster River and is therefore outside the Brown's River catchment area. Eight feet of storage in this lake would produce 1,260 acre-feet or somewhat more than the total of lakes 1 to 6 in the Brown's River watershed. A reconnaissance made between the lake and the upper reaches of Brown's River in Paradise Meadows discloses that the meadows are lower than the lake by 175 feet or thereabouts and that the length of a ditch to carry water from this lake into the Brown's River watershed would be approximately a mile, The topography of the country traversed between the two is very favourable for a ditch but an actual survey is required with some detailed examination of the nature and depth of the soil and the proximity of bed rock to the surface to indicate the ease or difficulty with which this diversion of water might be made. It may be possible to shorten the diversion by planning to take water from the creek below the lake outlet at just sufficient elevation to provide the necessary grade to discharge the water into the Brown's River watershed from whence it can make its own channel to the river.

Helen McKenzie Lake is in any event a valuable addition to the storage areas that may be made available to the City and should for reasons

to be given later perhaps be used in preference to the other lakes.

The depths of water flowing over a restricted area of the crest of the intake dam on Brown's River during the low water period of the past summer, which you have furnished me, show that there was at the lowest flow approximately 1¼ million gallons per day going to waste at that point. Water to the capacity of your present supply main, which has a capacity of about 500,000 gallons per day, has, I am advised, never failed you during the twenty years since the dam was built and there has always been some waste over it.

A consideration of these facts and the possibilities of storage above referred to convinced me that the City may reply upon Brown's River, supplemented with lake storage water, to supply a population 5 or 6 times greater than at present served.

Before leaving this aspect of the problem there are several observations that should be made.

The lakes in the watershed on the Forbidden Plateau are in an area of great natural beauty which has over the years, by much patient effort and expenditure of money, been made available to those who are physically fit to travel the trails. It is to be expected that as the years go by the relatively small number of persons who visit the area will increase. The substitution of a road for the trail over part of or the whole distance to the upper lakes, which is a future possibility, would greatly increase this number.

Human contamination of the water in the lakes during the summer would be quite possible. The possibility that the water would be used for domestic purposes in the City within a short time of its contamination would not provide that measure of safety associated with reservoirs where the period of detention of the water after contamination may run into a month or six weeks before its use. Within that time the harmful organisms such as typhoid bacilli, which cannot reproduce themselves in such an environment, becomes harmless. To overcome this possibility, which in any event would last not more than three months in the summer, it may be necessary to resort to sterilization of the water by chlorination for that period. For the present, with co-operation in sanitation of the authorities operating the tourist business in the Plateau and considering the relatively small number

of persons enjoying the advantages of visits to the area, the dangers from contamination are at least not greater than they have been. The question of sanitary quality of the water will be referred to later.

Another point not to be lost sight of is that storage in these lakes should be developed with the utmost regard for the preservation of the beauty of the area. No repetition of the raising of a lake leaving the newly submerged area in its original timbered condition, such as was done at MacKenzie Lake, should be practiced. The whitened and slowly rotting trunks of trees and undergrowth along the marginal area detract greatly from the scenic value of the lake and certainly do not add to the potability of the water. In all cases these marginal areas should be thoroughly cleared and the debris burned before raising the lake level.

One of the advantages of storage in Helen McKenzie Lake and its diversion to Brown's River lies in the fact that it is somewhat more remote and appears to be less frequently visited than the other lakes. Its large area and depth would make it - apart from the cost of the diversion ditch - cheaper in development per acre foot than the smaller lakes. As it has not the charm of the smaller lakes it may not be considered as one of the greater scenic assets of the plateau and might perhaps be set aside for water storage only - or with restrictions - and in this way the purity of its water be not interfered with.

INTAKE

The two points that seem largely to have suggested that the Brown's River Intake be removed to a point about 2 miles upstream near the Medicine Bowls were (1) the possibility of creating some local storage on the stream at the proposed new dam site, and (2) the increased hydrostatic head which would have made gravity water available to the Comox area.

As to (1), I am quite certain that the movement of gravel and boulders along the stream bed would in time largely, if not completely, fill the small reservoir proposed to be created by the suggested dam. On the other hand the construction of a pier and stop-log dam across the River on the solid ledge rock fifty feet or so upstream from the site proposed by Mr. Graham could be made to furnish a large proportion of the local storage suggested under the

other plan but with some outstanding advantages.

The cost of the dam would be relatively small as the piers only would be of concrete and the stop logs of wood. The stop logs would be used to improve water only toward the end of the spring run-off, the River would be unobstructed, except for the piers, during the remainder of the year and there would be no detention of the gravel and boulders that move downstream during floods.

By the insertion or removal of individual stop logs during the summer a closer adjustment of the storage water let down from Pearse Lake could be made. Such a dam would not appear to be essential, at least for several years but might be desirable at some later date to fulfill the purposes mentioned.

As to (2), even if Comox were to be supplied with 100,000 gallons of water per day, which is probably one-third of the present average total daily delivery from the City's service reservoir, the power cost at two (2) cents per K.W. hour with a reasonably efficient automatically controlled pump should not exceed $250.00 per year. This represents the interest at 5% on a capital sum of $5,000.00: in other words, leaving out of construction the small annual depreciation of the pumping equipment and the cost of superintendence which would be cared for in the supervision of the pipe lines, one could not afford to expend more than $5,000.00 in capital money to avoid pumping. The cost of providing facilities for bringing directly from the intake, by gravity, the quantity of water that might be required under the most generous anticipations of growth in that area would in my opinion be an unwarranted expenditure.

There is also to be considered the value of the present intake on Brown's River, which is at a suitable elevation to deliver water economically to the service reservoir. It is true that the low concrete dam does not appear to have been very well keyed into the solid rock upon which it is built and that there is considerable leakage through it. The pond that was originally created by the dam has been to a large extent filled with boulders and gravel to the crest level of the dam. The particular value of this structure, however, lies in the fact that for some little distance around and above the inlet of the supply pipe no debris accumulates. This inlet, I am informed by your

Water Officials, is never threatened by the inroads of gravel. A condition such as this in a rapidly flowing mountain stream is one to be treasured and not lightly to be disturbed. Consequently nothing should be done by way of raising the dam or otherwise (except in due time to grout it to prevent leakage) that would change the regimen of the stream at this point. When a new pipe is built the old intake box may be removed or filled. The new pipe intake should be placed in the solid rock that projects into the stream just a few feet above the present box. At this point the water in the pool is the deepest and if the pipe inlet is placed normal to the stream and at the projecting part of the rock the current in the stream will assist in keeping the inlet clear of floating material.

I understand that the title to the right-of-way for the pipe line has long since been obtained by the City but that the land surrounding the dam and intake had not been purchased. In response to your request a few weeks ago I recommended that the purchase of the latter should be made.

This may be the appropriate place to again refer to the sanitary situation with respect to the water supply. It is an unusual occurrence that a small public park should be developed directly on a stream used for city water supply above and only two miles distant from the water intake. This had taken place within recent years on Brown's River and however desirable it may be to have a small park at the Medicine Bowls it is a regrettable thing from the point of view of the purity of the water supply.

The only thing, apparently, that can be done about it now is to have instructions given to the caretaker in the park, during the months when it is used, that the utmost sanitary precautions must be taken against pollution of the water and the enforcement of strict sanitary regulations. Prominently placed notices to this effect should greet the eyes of all visitors.

In connection with all these sanitary aspects of the water system and as to the frequency with which bacterilogical examinations of the water should be made, it is the part of wisdom to keep in close touch with the Provincial Department of Health.

SUPPLY PIPE

The present wire wound wood supply pipe from Brown's River is 8 inches in diameter and extends, with the exception noted below, from the dam to the service reservoir situate about a mile outside the westerly boundary of the City. The total length of this pipe is 16,650 feet. The elevation of the dam crest is 254.37 ft. and the top of the reservoir wall is 178.34 ft., a difference in elevation of 76 ft.

At approximately mid-length of the line the Puntledge River is crossed. Here the old 8-inch pipe was replaced last year by a substantially constructed 12-inch diameter reinforced concrete steel cylinder pipe. This data is shown on the new profile recently made by Mr. Graham, copy of which is appended hereto. This profile confirms the correctness of the original profile by Donald Cameron, dated November, 1921, and on which the hydraulic gradient from dam to reservoir is given as 4.5 feet per thousand and the capacity of the pipe as 440 gallons per minute, which equals approximately 630,000 gallons per day. Subject to obstruction by accumulation of air which may fail to be relieved by imperfect or badly operating air valves on the summits of the pipe, this should be about the maximum actual delivery capacity. It must be observed that the pipe is not far below the hydraulic gradient at the summits both above and below the Puntledge crossing.

I am informed that the greater part of this pipe is still capable, with some attention, of performing its duty.

It will be advisable to make as much of it as possible serve to its limit of usefulness and to plan for its replacement later with a 12-inch diameter pipe. This will have a delivery capacity to the reservoir of approximately 1.5 million gallons per day or two and a half to three times the capacity of the present pipe.

Since there is little steel to be had in the market nowadays the deferring of the replacement as long as possible, to a time when a choice can be made of wood, steel or concrete, is desirable.

On account of the bad condition of the present pipe over the upper 1,500 feet or so from the dam, it should be replaced at the earliest opportunity preferably with a concrete pipe properly entrenched in the rock

that extends along the line for about that distance downstream. This should be 16 inches in inside diameter and be placed on a gradient of say one foot per thousand so to reduce the total loss of head. At the end of this section which should be selected for the purpose, a small housed twin settling tank should be built at which suspended matter and sand that may enter the intake can be settled out and discharged.

The main line leading from the reservoir into the City is also a wood pipe 12 inches in diameter. This pipe is reported as in very fair condition. Its replacement with a somewhat larger diameter pipe will in due course need consideration but the character and size of pipe required will better be determined when the time comes for renewal.

SERVICE RESERVOIR

In order to make the maximum use of the old 8-inch pipe, which is too small to carry the peak demands, it will be advisable to increase the reservoir capacity by adding another unit of 500,000 gallons, thus doubling its capacity. In this way it will be able to meet the peak demands and yet maintain a fair reserve of water. This, in addition to the provision of a supply of water near at hand in case of emergency, is the function of a service reservoir.

You have foreseen this requirement and already have acquired the land for that purpose. The interest on money saved in deferring pipe replacement as referred to above will assist materially in paying for the addition to the reservoir.

METERS

The total number of water services as at December 31, 1940, is given as 572 in the City and 214 outside, a total of 786, but no record of the quantity of water from day to day by the City or by Comox or Royston is available.

It is desirable and important that meters should be purchased right away and placed in the main pipe line at or near the service reservoir and at the City boundary on both the Comox and Royston pipes. Operations of a water system cannot be carried on with maximum efficiency or intelligently planned for the future without the positive information of a continuous record

under the varying seasonal conditions to be obtained only by metering main lines. Some such meter as the Crest or Sparling main-line types are inexpensive and of sufficient accuracy for this purpose.

CONNECTION TO PENSTOCK OF CANADIAN COLLIERIES LIMITED

The 4-inch City's pipe line which connects its distribution system with the power penstock of the Canadian Collieries delivering water from Comox Lake to the power plant on Puntledge River is a valuable standby in case of emergency.

The elevation of Comox Lake and its proximity to the City would have in the first instance made it an appropriate source of supply to the City. However, the power development preceded by several years the construction of the City's works from Brown's River and I understand consideration was given to this aspect of the question before the City embarked on the latter. The logging and other developments around the lake are fruitful sources of pollution but sterilization of the water could readily be applied. Should the unforeseen happen and Courtenay grow beyond all expectations it is fortunate in having so great a body of water near at hand even though all the water rights are presently held for power purpose.

For convenience of reference a copy of the agreement in respect of the connection facilities will be found in the Appendix.

A statement of the various water rights held by the City is also included in the Appendix hereto, as well as some small photographs taken at the mountain lakes.

COMOX AND ROYSTON

The supply of water by the City of Courtenay to Comox is made pursuant to By-law No. 146 of the City which received the assent of the electors on July 19, 1926, and was approved by Order of the Lieutenant-Governor in Council dated September 24, 1926.

Under the agreement referred to in the By-law certain persons referred to as the "Promoters" undertook to construct a 4-inch wire-wound wood pipe from a point within the City and following along the Comox Road to

the public wharf at Comox and to formally deliver possession of the pipe to the City who would supply the water and administer and maintain it. The City undertook to make the necessary connections and to distribute the water to the users.

Ninety-five per cent of the net revenues from the sale of water to consumers was to be paid by the City to the "Promoters" until they are reinbursed for the expenditure on the pipe line, subject to certain provisions, and on completion of payment the pipe became the property of the City. A copy of the By-law and agreement will be found in the Appendix hereto.

I am informed that the terms of the agreement were all compiled with and the pipe has long since become the City's property. There are 158 services off this line.

It may be noted that the agreement is silent on what may happen at the expiration of the useful life of the pipe and appurtenances. I understand that a considerable part of this pipe is now in bad condition.

Having dealt with the question of the proposed gravity supply to Comox, the further aspects of the matter come under the head of distribution and were not referred to me.

It may not be amiss, however, to point out that before replacement is undertaken of the long unproductive stretch of pipe line lying practically at sea level extending from the City to the foot of Siwash Hill, some examination might be made of the area immediately north of Comox where, it is reported, there are several springs. It would be advisable to ascertain whether water exists there in suitable quantity and quality to supply the Comox area and if it does whether there is any economy to be attained by securing and developing it and bringing it to Comox. This would seem to be the only alternative to a new pipe line from Courtenay to Comox - and possibly it is a remote one - that is worth investigating.

The supply to Royston is made pursuant to the City's By-law No. 183, which received the assent of the electors on January 17,1929 and was approved by the Inspector of Municipalities by Certificate dated July 22, 1929.

The By-law authorized the City to increase the capacity of its reservoir by not less than 50,000 gallons nor more than 100,000 gallons and to make an expenditure not to exceed $15,000.00 to supply water to persons along the Island Highway to Royston. The debentures to be issued by the City for

this purpose were to be payable in twenty years.

The pipe line as constructed is a 4-inch wire-wound wood pipe and is said to be in poor condition. The number of services on the Royston line is reported as 58 and there is in the records a statement to the effect that on measurement in May, 1933, the flow in the pipe was at the rate of 92,160 gallons per day. This quantity is of course severl times greater than any reasonable use through that number of services.

Since it has been in service not more than twelve years the pipe itself should still be substantially sound. If laid badly it should be valved at intervals, tested for leakage and relaid or reconditioned where required. This could be done over a suitable period of time, provided the lows of water through it in the interval causes no inconveniences or shortage elsewhere.

The policy of the City in carrying and distributing water to its neighbours outside the City limits was set a good few years ago and was approved by the ratepayers and by the Lieutenant-Governor in Council. Now that some expenditures for replacements are in the offing the question of policy may presently arise again.

It would seem to be desirable in advance of that time to re-examine the question of costs and to determine whether in view of the expenditures to be made the present rates to Comox and Royston will carry their fair share of the City's burden and responsibility. It is not suggested here that the rates are inequitable for I have made no study of that part of the problem.

There seems to be no method available for charging against the lands arrears of water rates, if any, in these areas, such as may be done under the provisions of the Municipal Act, in organized territories.

It might be well in this connection and also if thought desirable, to consider in respect of pipes laid outside the City, and where the facilities to give water services are built at the City's cost, whether a small frontage tax on adjacent lands unserved might not be fair and helpful. Some simple form of organization of the outside area such as an Improvement District under the Provincial Water Act might in that case be desirable.

SUMMARY

The recommendations contained in this report, briefly summarized, are that:

1. The waterworks intake be maintained at its present location.
2. Storage rights be obtained on certain mountain lakes and when and as required small storage works be created at their outlets; and if considered necessary at a future time a pier and stop-lpg dam be built on Brown's River in Medicine Bowls Park,
3. At a suitable time a survey and investigation be made of a suggested diversion from Helen McKenzie Lake and water storage and diversion rights be acquired there.
4. An additional unit be added to the service reservoir.
5. The present supply pipes be maintained to the limit of their useful lives; but that the upper quarter mile or thereabouts of the pipe from the intake be replaced by a new pipe and that a twin settling basin be constructed.
6. At a future date the remaining 8-inch from intake to reservoir be replaced by a pipe of 12 inches diameter.
7. Meters be installed now in the supply pipes.
8. Attention be given to the supply pipe to Royston in an endeavour to reduce the loss of water in that line.
9. Before any replacement is made of the long line to Comox an investigation is made of springs reported in the area to the northward to ascertain whether water could be more economically delivered to Comox than from City sources.
10. Consideration be given to the question of rates and other matters related to water service outside the Corporate limits.
11. Stirct sanitary precautions be observed in the lake region and at the small park at the Medicine Bowls. The Provincial Board of Health be consulted on all matters where there are possibilities of water contamination involved.

With care it is believed you may continue, for a few years, to make your present supply pipes to the City and the line to Royston continue to carry on. That will bring you close to the time when you will have paid for all the water works hitherto constructed and your financial condition in respect of these will be excellent.

Your necessary capital expenditures on the sytem for a time need not be very large and you have prudently been setting aside certain moneys in reserve. The future expenditures required to prove facilities for storage water and to reproduce or replace in larger size the supply parts of the system, as we suggested herein, will with care and judgment be very moderate for the population and importance of the community,

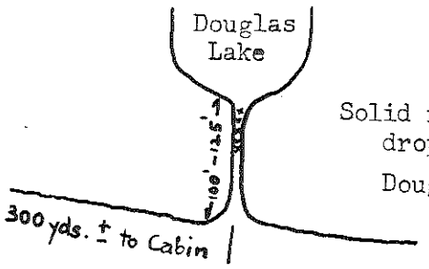
Every effort should be made to preserve all the advantages of your present excellent outlook,

Respectfully submitted,

(Signed)

Vancouver, B.C.
October 8th, 1941.

BRIEF NOTES RE LAKES IN FORBIDDEN PLATEAU
FOR CITY OF COURTENAY



Solid rock for about 65' from Douglas L. - level - then drops 3' or so. Total fall between lakes 5' or 6' ±
Douglas L. could be lowered.

McKenzie Lake

Croteau Lake. Elev. by Bar. 3950 ±

Small lake. Small catchment area. No storage (perhaps 1') available. Outlet exactly like Douglas Lake: solid rock. Could cut small ditch 50' or so and a drop of 2' could be obtained. Quite an extensive camp - Croteau's on shore of lake. Very beautiful spot with fine view of Mt. Albert Edward and Castle Mtn. Would be inadvisable to consider this little lake for storage purposes.

Lady Lake. Elev. 3850 ±

About 15 minutes walk from Croteau Camp. Beautiful lake - looks to have considerable depth in middle. Outlet over solid rock. About 30' of rock trench to a drop of 12'. Probably would need 200' or so of trench in lake bottom. Easy facilities for a storage of 2' above present level without encroaching on forest growth. Water now flowing over outlet about 1/2 c.f.s.

Helen McKenzie Lake. Elev. 3700' by Bar.

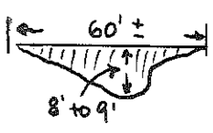
Deep fine lake. Can see Mt.Albert Edward only of the higher peaks. Rise to Elev. 3800 on trail returning to level of Battleship Lake.

Proceeded to Brown's River and up to and through Paradise Meadows (Elev. by Bar. 3540) Decided to try crossing country to Helen McKenzie Lake on approximate route of a ditch that could be constructed to divert water from Helen McKenzie Lake to the Brown's River watershed. Kept as nearly as possible at Elev. 3600' - 3700'. At N.W. corner of meadow the divide to Oyster River catchment is only 100 yds. or less away and but 50' (about) above meadow. From this point we bore southerly along fairly even but in some places fairly steep hillside to Helen McKenzie Lake. Distance deemed (and from map appears) about a mile. Arrived Helen McKenzie Lake (Bar. 3720) Outlet now discharging 2 to 3 c.f.s. Apparently loose rock lying on solid rock with numberous small dead logs. Could raise Lake 5' or so easily. Abundant yellow cedar timber for a dam - perhaps 30' long. Lake has at H.W. been about 30" higher than present level. The outlet stream falls pretty fast. Did not have time to travel to outlet of Battleship Lake nor did we recognize the small stream that must run from the lake into the meadows in our trip up the meadows.

Johnson Lake. Elev. 3750 by Bar.

The best place for a dam would (apparently) be about 100 yards down the tiny stream from lake outlet. The stream fall in that distance would be (probably) not more than 6" below present lake level.

A small log dam in a cross-section like this:



would raise the lake about 8'.
As Johnson Lake is off main trail (only though 5 to 10 minutes) it apparently is very infrequently visited and would furnish considerable storage at small cost.

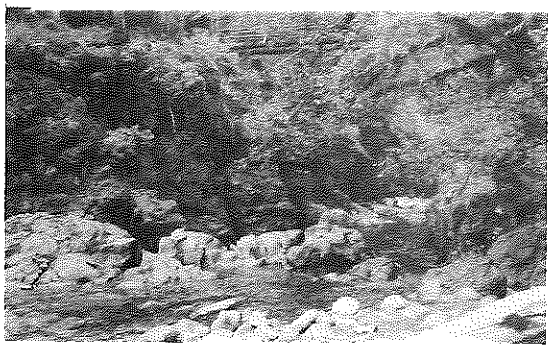
Pearse Lake:

Outlet is solid rock and falls about 8' or 9' in 50' than another 20' on a 45° slope. Solid conglomerate rock. At highest point of outlet length across is about 50'. Almost level in cross-section; slightly irregular surface. Crest is about level up and down stream for about 25' or 30'. Then another 40' or 50' by narrow ditch would give 3' depth. Could not estimate with any certainty, but color of water suggests that another 50' farther into lake might give a depth of 8' or 10'.

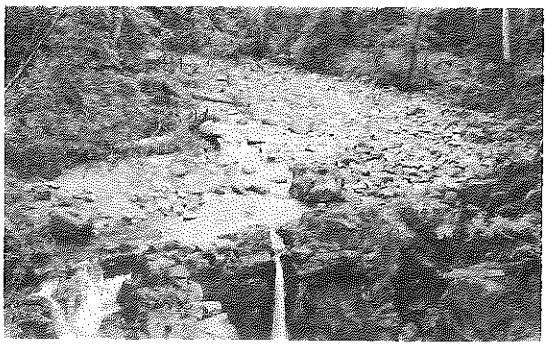
On account of relatively low land at each side of ourlet a short dam could raise lake level by only 3'.

Vancouver, B.C.

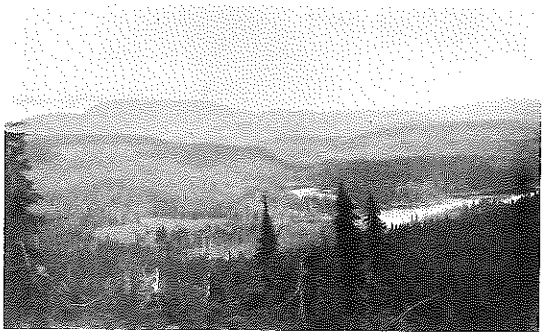
August, 1941.



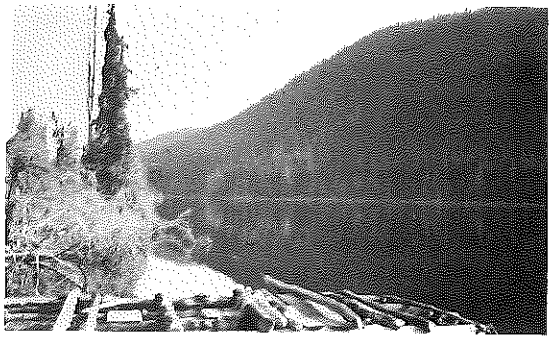
Looking down Brown's River into dam site proposed by Mr. Graham. Park bridge in upper background



Solid ledge rock crossing river. Looking upstream from Park bridge

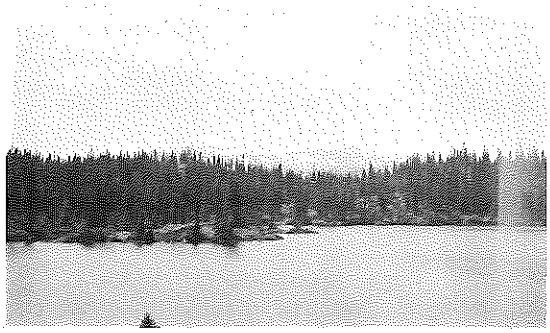


Looking over Douglas (centre) and McKenzie Lakes from a point on trail to Forbidden Plateau

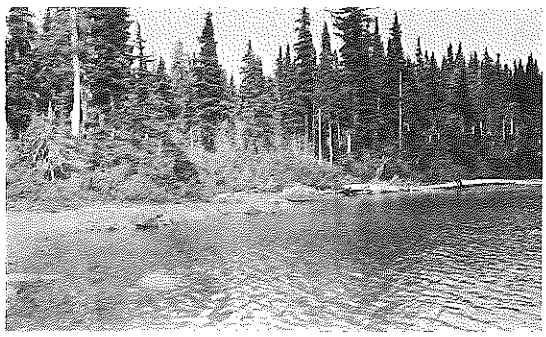


Looking across and down McKenzie Lake from Tourist Lodge.

Looking upstream to small dam at outlet of McKenzie Lake

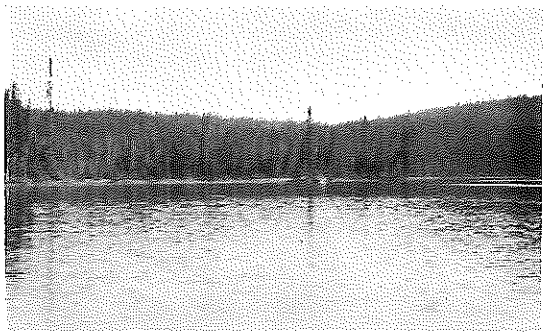


On Helen McKenzie Lake

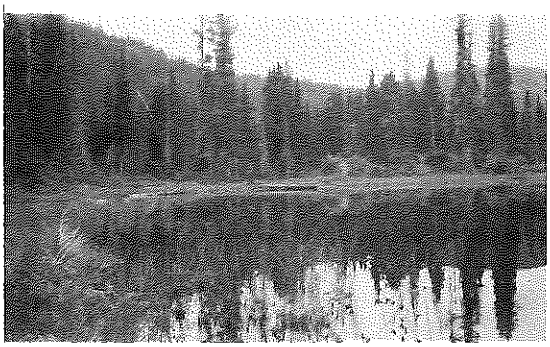


Outlet of Helen McKenzie Lake
at boulder near left end of log.

Looking across Marywood Lake toward
tourist Lodge in early morning.



Looking S.W.across Johnson Lake
from point near outlet.



Outlet of Pearse Lake in centre
middle distance

COPY

THE CORPORATION OF THE CITY OF COURTENAY

Cumberland
British Columbia
August 31, 1926
Registry

BY-LAW NO.146

Reg.#100

A BYE-LAW TO AUTHORIZE THE ENTERING INTO OF AN AGREEMENT FOR THE EXTENTION OF THE WATER-WORKS SYSTEM TO COMOX.

WHEREAS James A. Carthew, Robert J. Filberg and others propose to construct a water pipe line extending from the termination of the City's four inch pipe line along the highway known as the Comox Road to the public wharf at Comox and desire to obtain a supply of water for said water pipe line from the City:

AND WHEREAS the City is willing to supply water to said water pipe line subject to the terms and conditions contained in the Agreement set out in the Schedule to this Bye-Law on condition that said water pipe line shall become the property of the City as in said Agreement provided;

NOW THEREFORE the Municipal Council of the Corporation of the City of Courtenay enacts as follows:

1. It shall be lawful for the Corporation of the City of Courtenay to supply water to the water pipe line to be constructed by James A. Carthew, Robert J. Filberg and others in accordance with the terms and conditions in the Agreement set out in the Schedule to this Bye-Law, and to become the owner of said pipe line as in said Agreement provided.

2. The Mayor and Clerk of the Corporation are hereby authorized and directed to execute the Agreement set out in the Schedule hereto, on behalf of the Corporation and to affix to it the seal of the Corporation.

3. This Bye-Law shall be cited as "The Comox Water-works Extension Bye-Law."

Passed the Municipal Council the 5th day of July, 1926.

Received the assent of the electors the 19th day of July, 1926.

Reconsidered, adopted and finally passed by the Municipal Council the 23rd day of August 1926.

City of Courtenay Seal

(Signed) J.W. McKenzie Mayor

(Signed) C.S. Wood Clerk of the Municipal Council.

I HEREBY CERTIFY that the foregoing is a true and correct copy of Bye-Law No. 146, as finally passed by the Municipal Council of the Corporation of the City of Courtenay on the 23rd day of August 1926

(Signed) C.S. Wood
Clerk of the Municipal Council

I HEREBY CERTIFY that a true copy of this Bye-Law was registered in the Registry of the County Court of Nanaimo, holden at Cumberland, B.C. this 31st day of August 1926.

(Signed) John Conway
Registrar of the County Court
of Nanaimo holden at Cumberland.

SCHEDULE

MEMORANDUM OF AGREEMENT made and entered into in duplicate this 5th day of July, 1926;

BETWEEN: JAMES A CARTHEW, Farmer, of Comox, in the Province of British Columbia and Robert J. Filberg, Superintendent, of Headquarters in said Province; Hereinafter called "The Promoters":

OF THE ONE PART:

AND THE CORPORATION OF THE CITY OF COURTENAY, a Municipality duly organized under the laws of the Province of British Columbia: Hereinafter called "the City"

OF THE OTHER PART:

WHEREAS the Promoters desire to obtain a supply of water for the use of the residents of an adjoining Comox in the Province of British Columbia;

AND WHEREAS the City is the holder of a License to take and sell water from Browns River in the Province of British Columbia and has constructed and owns works for supplying water to the inhabitants of the City;

AND WHEREAS the Promoters propose to construct a pipe line and other works to connect with the City's pipe line within the limits of the City;

AND WHEREAS the City is willing to supply water to the promoters subject to the provisions of this agreement.

WITNESSETH that in consideration of the premises, the said parties hereto mutually covenant and agree as follows:

1. The Promoters shall, within one month after the coming into effect of this agreement, commence and proceed with, with all reasonable dispatch, the construction of a pipe-lien extending from the existing termination of the City's four inch pipe line within the municipal limits along the highway known as the Comox Road to the public Wharf at Comox.

2. Said Pipe line shall be constructed of four inch wire wound wood stave pipe with steel couplings (double burlapped where required by the Inspector). The pipe shall be laid at a uniform depth of not less than eighteen inches and shall be otherwise protected where required by the Inspector. The pipe shall be suitable for carrying such head - not exceeding 200 feet - as shall be prescribed by the Inspector. Gate valves to the number of not more than three shall be inserted in the line where directed by the Inspector. Standard air valves of approved type must be inserted at all points where the level of the ground requires them.

3. The City shall appoint an Inspector whole duty shall be to see that said pipe line is constructed in accordance with paragraph two hereof. The promoters shall, within twenty-four hours after being notified to that effect by the Inspector replace any defective materials and remedy any defects in construction.

4. Upon the completion of the main water pipe line, the Promoters shall formally deliver to the City possession of the same.

5. All connections with the main water pipe shall be of half inch pipe except when express permission shall have been given by the

City and shall be made by an employee of the City and the consumer shall pay to the City the tapping charge made therefor.

6. The administration and control of the water pipe line constructed by the Promoters shall be vested solely in the City from the date of possession being taken.

7. The City will maintain the pipe line in a proper state of repair at the expense of the Promoters.

8. The City will act as the agent of the Promoters in collecting the revenue accruing from the pipe line in the manner, so far as applicable, used to collect revenue from its own sytem. The City will however, in no case, be liable for any loss arising from failure to collect any revenue accruing due. The City shall be entitled to retain for its own use five per centum of the gross revenue from the pipe line as compensation for its services in acting as the Promoters' agent.

9. At the expiration of six months from the taking of possession of the pipe line by the City, the City will pay to the nominee of the Promoters the net revenue which has accrued from the pipe line without the Municipal limits after deducting five per centum of the gross revenue and the cost of all repairs, and thereafter the City shall, at the expiration of every period of six months, pay to the nominee of the promoters, the net revenue as aforesaid until the cost of constructing the original water pipe line and other works (not to exceed $10,000.00) together with interest at 5% on the same or the balance from time remaining, shall have been paid to the Promoters. Upon payment of the cost or the sum of $10,000.00 (whichever sum shall be the less) and interest at 5% in manner aforesaid or upon payment by the City at any time of the balance required to make up said amount, the said pipe line and other works constructed by the Promoters shall become the absolute property of the City. IT IS EXPRESSLY AGREED HOWEVER that in the event of the net revenue for a period of twelve years after the taking of possession of the line by the City being sufficient to repay the cost or the sum of $10,000.00 as the case may be and interest, as aforesaid, the pipe line and other works shall become the absolute property of the City at the expiration of said period; PROVIDED HOWEVER that the Council of the Corporation may, in its discretion, extend the time for payment of the cost or the sum of $10,000.00, for a further period not exceeding three years.

10. The Promoters shall not encumber or charge in any way the pipe line and other works constructed by them,

11. The City reserves the right to curtail or shut off the supply of water to the Promoters' pipe line, without notice, in case of emergency, or upon twenty-four hours' notice, in other cases. The City shall in no case be liable for shortage or failure of water supply.

12. The fees and charges to be made for water supplied to consumers from the Promoters' pipe line shall be those in force at present for water supplied within the City from the City's pipe line increased by twenty-five percent.

13. The Promoters shall obtain from all consumers a written contract, which contract shall in form be approved by the City, prescribing the terms and conditions upon which water shall be supplied and used.

14. No extention of the Promoters' pipe line beyond that set out in Paragraph One hereof shall be made without the consent of the City.

15. The Promoters shall not be entitled to any revenue accruing from the pipe within the Municipal limits.

16. No assignment of the rights and priviledges hereby granted shall be made by the Promoters without the consent of the City.

17. This Agreement shall not come into force until assented to by the electors of the City and approved by the Lieutenant-Governor in Council.

IN WITNESS WHEREOF the Promoters have hereunto set their hands and seals and the City has caused its common seal to be affixed.

Signed, sealed and delivered by Jas.A. Carthew and Robert J. Filbert in the presence of:

Jas. A. Carthew

R.J. Filberg

The common seal of the Corporation of the City of Courtenay was hereunto affixed in the presence of:

The Corporation of the City of Courtenay

J.W. McKenzie, Mayor

C.S. Wood, Clerk of the Municipal Council.

COPY

(Signed) I.L. White
DEPUTY CLERK, EXECUTIVE COUNCIL

THE GOVERNMENT OF THE
PROVINCE OF BRITISH COLUMBIA

CERTIFIED COPY OF A MINUTE of the Honourable the Executive Council, approved by His Honour the Lieutenant-Governor on the 25th day of September, 1926.

No. 1060

TO HIS HONOUR

THE LIEUTENANT-GOVERNOR IN COUNCIL:

The undersigned has the honour to recommend

That pursuant to the provisions of Clause (24) of Section 54 of the "Municipal Act", being Chapter 179 of the Revised Statutes of British Columbia, 1924, By-Law No. 146 of the Corporation of the City of Courtenay, cited as "The Comox Water-Works Extension By-law", be approved:

AND THAT a certified copy of this Minute, if approved, be transmitted to C.S. Wood, Clerk of the said Corporation at Courtenay, B.C.

DATED THIS 24th day of September A.D. 1926

"A.M. MANSON"

Attorney-General

APPROVED this 24th day of September A.D. 1926

"JOHN OLIVER"

Presiding Member of the Executive Council

COPY

CORPORATION OF THE CITY OF COURTENAY

BYE-LAW NO. 183.

Cumberland
British
Feb.19, 1929
Columbia Registry
#134

A BYE-LAW TO AUTHORIZE THE CONSTRUCTION OF ADDITIONAL WORKS FOR SUPPLYING WATER FOR DOMESTIC PURPOSES TO INHABITANTS IN LOCALITIES ADJACENT TO THE MUNICIPALITY OF COURTENAY AND TO RAISE THE NECESSARY MONEYS FOR SUCH CONSTRUCTION.

WHEREAS various persons resident adjacent to the Municipality of Courtenay have requested the Corporation to supply them with water for domestic purposes;

AND WHEREAS said persons have executed a contract in the form in Schedule "A" to this Bye-Law covenanting and agreeing to pay for said water and to abide by the conditions as therein contained;

AND WHEREAS it is expedient that works be constructed to supply water for domestic purposes to the persons resident along or adjacent to the Island Highway from the Corporation limits to Lot 15, Blk. "J", Sec. 6-A, Nelson Dist. Map. 1478;

AND WHEREAS it will be necessary to increase the reservoir capacity of the water system of the Corporation for said purpose;

AND WHEREAS the estimated cost of such proposed works is the sum of Fifteen Thousand Dollars ($15,000.00);

AND WHEREAS for the purpose and with the object aforesaid it is necessary to issue upon the credit of the Corporation of the City of Courtenay debentures to the amount of $15,000.00 payable in twenty years, from the date thereof, and bearing interest at the rate of five per centum per annum;

AND WHEREAS the said sum of $15,000.00 is the amount of the debt intended to be created by this Bye-Law;

AND WHEREAS it will be necessary to raise annually the sum of $558.24 for the payment of the debt and the sum of $750.00 for the payment of interest theron making in all, the sum of $1308,24 to be raised annually for the payment of the debt and interest;

AND WHEREAS the total value of the rateable lands and improvements within the Municipality according to the last revised assessment roll is $963,754.00;

AND WHEREAS the value of the electric light and power system purchased, constructed and owned by the Municipality as determined by the Auditor is $76,061.93;

AND WHEREAS the value of the water system constructed and owned by the Municipality as determined by the Auditor is $119,719.59.

AND WHEREAS the existing debenture debt of the Corporation is $172,036.33 for other than school purposes;

THEREFORE the MUNICIPAL COUNCIL OF THE CORPORATION OF THE CITY OF COURTENAY ENACTS AS FOLLOWS:

1. The Municipal Council of the Corporation of the City of Courtenay is hereby authorized to construct works for supplying water for domestic purposes to the residents along or adjacent to the Island Highway from the Corporation limits to Lot 15, Blk. "J", Section 6-A, Nelson District, Map 1478. The pipe used shall not exceed four inches in diameter.

2. The Municipal Council of the Corporation of the City of Courtenay is hereby authorized to enlarge the reservoir capacity of the water system owned

by the Corporation by at least fifty thousand gallons but not more than one hundred thousand gallons.

3. The total cost of the works authorized by parts 1 and 2 hereof shall not exceed $15,000.00

4. The entering into of contracts by the Corporation in the form set out in Schedule "A" to this Bye-Law with persons desiring to obtain water is hereby authorized and ratified. The Council may from time to time, by resolution or Bye-Law alter or amend such form of contract as it may think best.

5. For the purpose and with the object aforesaid, there shall be issued upon the credit of the Corporation debentures to the amount of $15,000.00 in sums of not less than $100.00 each and each of such debentures shall have coupons attached for the payment of interest.

6. The debentures shall be payable in twenty-years from the date thereof.

7. The debentures shall bear interest at the rate of five per centum per annum payable half-yearly and as to both principal and interest, shall be expressed in Canadian currency and shall be payable at the principal office of the Canadian Bank of Commerce in the cities of Vancouver, Victoria, and Courtenay in the Province of British Columbia, and in such other planes as the Council may be resolution determine.

8. The debentures and the interest coupons shall bear the signatures of the Mayor and the Treasurer of the Corporation and shall be sealed with the seal of the Corporation but the signatures on the coupons may be either written, stamped, printed, engraved or lithographed.

9. During twenty years, the currency of the debentures, the sum of $558.24 shall be raised annually to form a sinking fund for the payment of the debt and the sum of $750.00 shall be raised annually for the payment of the interest thereon, making, in all the sum of $1308.54 to be raised annually for the payment of the debt and the interest. The said sum of $1308.54 shall be raised and levied in each year during the currency of the debentures by a rate sufficient therefor on all rateable land or lands and improvements within the Municipality.

10. This Bye-Law shall be known and cited for all purposes as "The Royston Waterworks Extention Authorization and Debenture Bye-Law".

Passed by the Municipal Council this 28th day of December 1928.

Received the assent of the Electors on the 17th day of Jan. 1929.
Reconsidered, adopted and finally passed by a three-fourths majority of all the members of the Municipal Council this 21st day of January, 1929.

(Signed) THEED PEARSE Clerk

(Signed) C.S. WOOD Mayor.

of the Municipal Council.

I HEREBY CERTIFY that the foregoing is a true and correct copy of "The Royston Waterworks Extension Authorization and Debenture Bye-Law No. 183, 1929" as finally passed by the Municipal Council of the Corporation of the City of Courtenay on the 21st day of Feb. 1929.

Dated at Courtenay this 13th day of February 1929.

(Signed) C.S. Wood Clerk
of the Municipal Council

I HEREBY CERTIFY that the foregoing Bye-Law viz "The Royston Waterworks Extension Authorization and Debenture Bye-law No. 183, 1929" of the Corporation of the City of Courtenay was registered in the Registry of the County Court of Nanaimo holden at Cumberland.

Dated the 19th day of February 1929

CITY SEAL

(Signed) John Conway
Registrar of the County Court
of Nanaimo holden at Cumberland.

SCHEDULE "A".

CITY OF COURTENAY

CONTRACT FOR WATER SERVICE MADE and entered into

BETWEEN

THE CORPORATION OF THE CITY OF COURTENAY, Hereinafter called the "City"

OF THE ONE PART:

AND

.....hereinafter called the "Consumer"

OF THE OTHER PART.

WHEREAS the Consumer has requested the City to lay and maintain pipes and other apparatus for connecting at a point on the public highway with the pipes of the Consumer to supply him with water for domestic purposes, and the Consumer has agreed to enter into a contract guaranteeing to the City the payment by him to it of a minimum yearly revenue of $ for a period of ten years, and has agreed to be bound by the terms and conditions of this contract;

NOW THERFORE IT IS AGREED by and between the parties hereto as follows:

1. The City agrees to extend its water pipes to connect with the pipes of the Consumer at a point on the public highway opposite the property of the consumer, viz:

2. The Consumer covenants and agrees to pay to the City the minimum yearly revenue of $ for ten years to be computed from the date upon which the City is prepared to supply water to the Consumer, in manner following: In monthly instalments according to the usual practice of the City in rendering bills, except that the first yearly minimum must be paid in advance. IT IS EXPRESSLY UNDERSTOOD AND AGREED that if the Consumer makes default in payment of any monthly bill for water for a period of thirty days after the same has become due the City may, at its option, declare the entire minimum revenue for the remainder of the period of ten years to be forthwith due and payable and the Consumer shall thereupon pay such minimum revenue to the City.

3. The Consumer shall pay a tapping charge of $5.00 for connection by the City of his pipe to the City's system for a ½" pipe and an amount to be computed by the City's Waterworks Supt. for a larger size pipe.

4. In case default shall be made in the payment of any month's rate, the City may in addition to declaring the minimum revenue due, discontinue the service without notice. In such event, the service will not be renewed until payment of all arrears and a fee of $1.00 for connecting the service has been made.

5. The City reserves the right to shut off or curtail the supply of water in cases of emergency without notice and, in other cases, on twenty-four hour' notice.

6. The City shall in no case be liable for shortage or failure of water supply.

7. Any employee of the City shall have the right at all reasonable times to enter upon the lands and premises of the Consumer for any purpose in connection with the repair or maintenance of the City's system.

8. The Consumer shall comply with all regulations, terms, conditions and rates regarding the use of water which may be imposed by the City hereafter.

9. It is expressly understood and agreed that this contract shall not be binding upon the City until a Bye-law authorizing the construction of the necessary works has been duly passed by its rate-payers and shall have received the assent of the Lieutenant-Governor in Council.

10. It is further agreed and declared that this agreement and everything herein contained shall respectively enure to the benefit of and be binding upon the parties hereto, their heirs, executors, administrators, successors and assigns respectively.

IN WITNESS WHEREOF the parties hereto have caused these present to be executed this day of 1948.

The Common seal of the Corporation of the City of Courtenay was hereunto affixed in the presence of:

Signed, sealed and delivered by the Consumer in the presence of

"MUNICIPAL ACT"

CANADA

No.C.1369

Province of British
Columbia

CERTIFICATE OF APPROVAL.

In pursuance of the "Municipal Act," I hereby certify that the within By-Law, being By-Law No. 183, cited for all purposes as "The Royston Waterworks Extension Authorization and Debenture By-law", as ammended by By-law No.190, cited as "The Royston Waterworks Extension Authorization and Debenture By-law Amendment By-law" of the Corporation of the City of Courtenay, has been lawfully and validly made an enacted, and that its validity is not open to be questioned on any ground whatever in any of the Courts of the Province of British Columbia.

Dated this twenty-second day
July, 1929

Inspector of
Municipalities of
British Columbia
Seal

(Signed) R. Baird

Inspector of municipalities
of British Columbia.

COPY

CORPORATION OF THE CITY OF COURTENAY

BYE-LAW NO. 190

Cumberland
Registry
May 29, 1941
#141

Certificate of Approval
Attached to Bye-Law 183.

A BYE-LAW TO AMEND "THE ROYSTON WATERWORKS EXTENSION AUTHORIZATION AND DEBENTURE BYE-LAW."

THE MUNICIPAL COUNCIL OF THE CORPORATION OF THE CITY OF COURTENAY ENACTS AS FOLLOWS:

1. The Royston Waterworks Extension Authorization and Debenture Bye-Law is hereby amended by adding the following paragraph after the fourth paragraph in the preamble -

AND WHEREAS said extension and the plans and specifications therefor have been approved by the Provincial Board of Health;

2. This Bye-Law may be cited as "The Royston Waterworks Extension Authorization and Debenture Bye-Law Amendment Bye-law."

Passed the Municipal Council the 15th day of April 1929.

Reconsidered, adopted and finally passed the Municipal Council this 6th day of May 1929.

(Signed) Theed Pearse Mayor
(Signed) C.S. Wood City Clerk

I HEREBY CERTIFY that the foregoing is a true and correct copy of "The Royston Waterworks Extension Authorization and Debenture Bye-law Amendment Bye-law". No. 190 as finally passed by the Municipal Council of the Corporation of the City of Courtenay on the 6th day of May 1929.

Dated at Courtenay this 27th day of May, 1929.

(Signed) C.S. Wood Clerk
of the Municipal Council.

I HEREBY CERTIFY that a true copy of "The Royston Waterworks Extension Authorization and Debenture Bye-Law Amendment Bye-law No. 190 was registered in the Registry of the County Court of Nanaimo this 29th day of May 1929.

(Signed) John Conway
Registrar of the County
Court of Nanaimo holden
at Cumberland.

LIST OF WATER RIGHTS HELD BY CITY OF COURTENAY

Date	Licence C.L.	Final	Source	Licensee	Quantity	Intake	File #	Remarks
27 August, 1917	O.C.	905	Brown's River	Reserve for waterworks	10 c.f.s.		9674	L.I. 39612
19 March, 1920	5628	6038	" "	City of Courtenay Undertaking of Corp.	250,000 g.d. W.wks.	B 4820	0 19364	For storage see F.L. 7969. For Territory see B.C Gazette Ps 295-6 3 Feb. 1927
26 August, 1926	9503	7969	" "	City of Courtenay Storage for F.L. 6038	340 ac.ft. Storage	R M 69 (C-7)	0 71386	Storage in Pearse and McKenzie Lakes
6 July, 1936	13028		" "	✱ Corpn. of the City of Courtenay Amending Certificate of Approval of undertaking dated Sept.9/36	750,000 g. a day W.wks.	B.4820	0 19364	For territory see B.C. Gazette dated 24 Sept. 1936 page 1551

✱ Date of Completion
Dec. 31/43

COPY

Province of
British Columbia

WATER RIGHTS BRANCH

Department of
Lands.

AMENDING
CERTIFICATE OF APPROVAL OF UNDERTAKING

WHEREAS the Corporation of the City of Courtenay is the holder of certificate approving its undertakings relative to the diversion and use of 250,000 gallons of water a day from Brown's River in Nanaimo Water District and the storage of 2000 acre-feet of water per annum in Kilakilama Lakes for workworks purpose.

AND WHEREAS the Corporation has made application for a licence to authorize the diversion and use of an additional 750,000 gallons of water a day from Brown's River for workworks purpose.

AND WHEREAS the Corporation has petitioned for the approval of its undertaking in respect of the said application.

AND WHEREAS it appears in the public interest to grant the prayer of the Corporation's petition.

THIS IS TO CERTIFY that the undertaking of the Corporation of the City of Courtenay relative to the diversion and use of 750,000 gallons of water a day from Brown's River in Nanaimo Water District for waterworks purpose as the said undertaking is outlined in the petition of the Corporation filed with the Comptroller of Water Rights on July 15th, 1936, is hereby approved subject to the provisions of the Water Act and following conditions.

1. The construction of the works necessary to divert and use the water shall be commenced by May 1st, 1938 and shall be carried out to the satisfaction of the Comptroller of Water Rights.

2. The territory within which the corporation may distribute and sell the water diverted from Brown's River comprises those parts of Comox and Nelson Districts lying within a radius of four and one-half miles in a southerly direction between Comox Harbour and Puntledge River and within a radius of six miles in other directions from the intersection of Alice and Isabel Streets in the City of Courtenay.

3. This Certificate does not authorize the diversion of any water or the construction of any works nor is it an approval of any plans of any works.

Dated at Victoria, B.C. the 9th day of September, 1936.

"H. Cathcart"
Deputy Minister of Lands.

I hereby certify the above to be a true copy of a document in my official custody.

Deputy Minister of Lands.

COPY

Order-in-Council 905*17

TO HIS HONOUR

THE LIEUTENANT-GOVERNOR IN COUNCIL:

THE UNDERSIGNED HAS THE HONOUR TO REPORT FOR THE CONSIDERATION OF THE COUNCIL THE FOLLOWING:

THAT the Corporation of the City of Courtenay has requested that a reserve for waterworks purposes be placed on Brown's River in the Nanaimo water District.

THAT it is considered to be in the public interest that the waters of this river be reserved as a source of supply for a waterworks system.

AND TO RECOMMEND THAT ten (10) cubic feet per second of the unrecorded water of Brown's River in the Nanaimo Water District be reserved for Waterworks purpose.

AND THAT the Comptroller be ordered to register the reserve of the said ten (10) cubic feet of water per second and the terms and condtions under which the whole or part thereof may be acquired.

AND THAT a licence for the above water may be acquired for waterworks purpose on complying with the requirements of the "Water Act, 1914" Amendment Act, 1917" and on obtaining the consent of the Minister of Lands to the issue of a licence.

DATED THIS 27th day of August A.D. 1917

Minister of Lands.

APPROVED THIS 27th day of August A.D. 1917

Presiding Member of the Executive Council.

COPY

CANADIAN COLLIERIES (DUNSMUIR)LTD.
Marine Building,

Vancouver, B.C. August 30, 1940.

To the City Clerk,
City of Courtenay,
Courtenay, B.C.

Dear Sir:

The use by the City of our connection facilities at Puntledge will terminate as at 31st of August next, and we will invoice you as agreed at the rate of $2.50 per day for the period December 1st, 1939, to August 31st, 1940, or 274 days at $2.50, making $685.00

With regard to these same facilities being at the City's call after 31st August 1940 to supplement its water supply at any time it desires to do so, we are agreeable to this, subject to the City agreeing to pay us from and after 1st September next 50 cents a day as a standby charge, and an additional $3.50 for each day or any part thereof when such facilities are actually used by the City. We will invoice you monthly on this basis.

Our power house engineer is to have full control of the water valves. Our obligation under this arrangement is to permit the City's use of the above connection facilities, and we accordingly are not to be liable in any way for the supply of water or for any interruption in such supply or for any pollution of such water.

This arrangement is terminable by either party on thirty days' written notice to the other.

We are sending this letter in duplicate, and shall be glad if you will kindly return one copy signed under the word "Confirmed".

Yours truly,

CANADIAN COLLIERIES (DUNSMUIR) LTD.,
Signed "Harold Baird", Superintendent

Approved:

Signed "H.R. Plommer" General Manager.

Confirmed:
City of Courtenay "Charles Simms"
Mayor
"Fred. W. Tull" City Clerk.

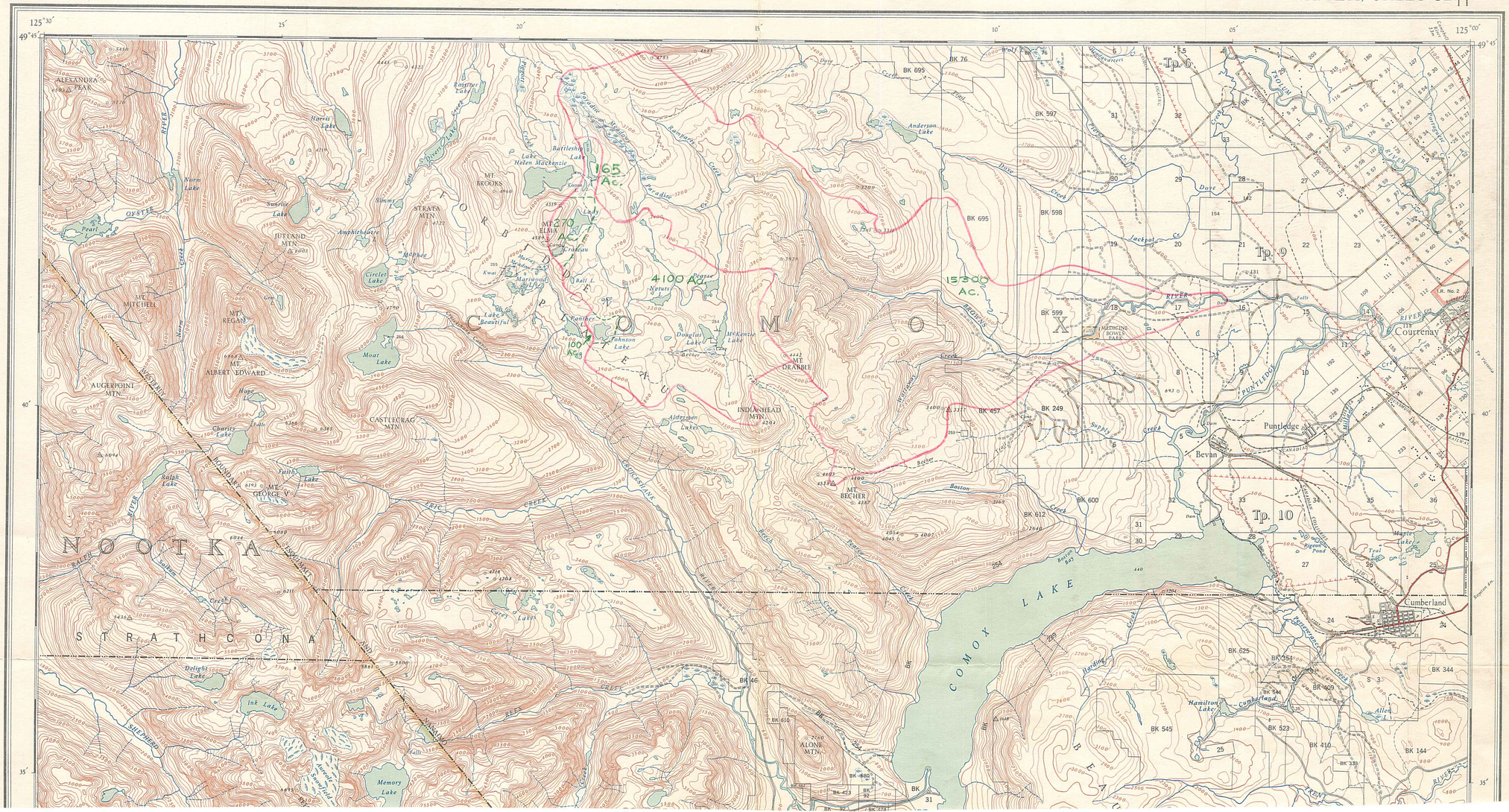
BRITISH COLUMBIA

DEPARTMENT OF LANDS AND FORESTS

NATIONAL TOPOGRAPHIC SERIES

FIRST EDITION

CANADA, SHEET 92 F/11



CORPORATION OF THE CITY OF COURTENAY, B.C.

REPORT ON PROPOSED DIVERSION OF OUTLET CREEK FROM LAKE HELEN MACKENZIE

June 1947.

4606 W. 3rd. Ave.,
Vancouver, B.C.

To His Worship the Mayor
and Council,
Corporation of the City of Courtenay,
Courtenay, B.C.

Gentlemen:

PROPOSED DIVERSION
OF LAKE HELEN MACKENZIE

Pursuant to your letter of instructions dated June 20th, 1946, to make a survey for the diversion of the overflow from Lake Helen MacKenzie to Paradise Meadows. in the Watershed of the Browns' River. I beg to report that I made arrangements in Courtenay on 26th August to proceed to the Forbidden Plateau the following day.

On arrival at the site of the work I found that the ground was clear of snow, and proceeded to run alignment and levels from the outlet of Piggott Creek in the direction of the Paradise Meadows. The work carried out is shown on plan "D". It will be noted that the line commences at point "A" the outlet of the creek from Lake Helen MacKenzie where a diversion dam would require to be constructed, and is carried only as far as a small lake marked "B".

It was quite obvious that on reaching this point that a considerable amount of time would be required to complete a preliminary line to connect to Paradise Meadows at point "B".

I decided therefore not be entail further expense by continuing the field work but to obtain aerial photographs which would indicate what obstacles might be met with on the continuation of the line, and thus facilitate further field work.

I have had an enlarged air photograph made of the area between Helen MacKenzie Lake and Paradise Meadows marked "A", a plan marked "B" made from this air photograph, and a series of flight photographs showing the limit of the Brown's River Watershed and marked "C"

On sheet "A" elevations are shown.

Lake Helen MacKenzie	elevation	3700'
Small Lake at "B"	"	3572'
(elevation determined from levels)		
Elevation at "C" Paradise Meadows		3520'

It will be noted that there is a high point between "B" and "C" on the watershed line which on further investigation might be found to be at such an elevation that it would entail heavy excavation for ditching.

The proposed line would require to be close against the steep mountainside indicated on the photograph.

From the bottom of the slope of the mountainside the ground slopes rapidly to the west and drains to Piggott Creek.

The above information is again given on sheets "B" and "C" but on sheet "C" the line of the Browne's River Watershed is shown and also many of the Lakes which are a source of supply to Browne's River.

Before a recommendation could be made as to the practicability of this scheme it would be necessary to make further investigation, particularly to determine the elevation of the high point on the Watershed

line.

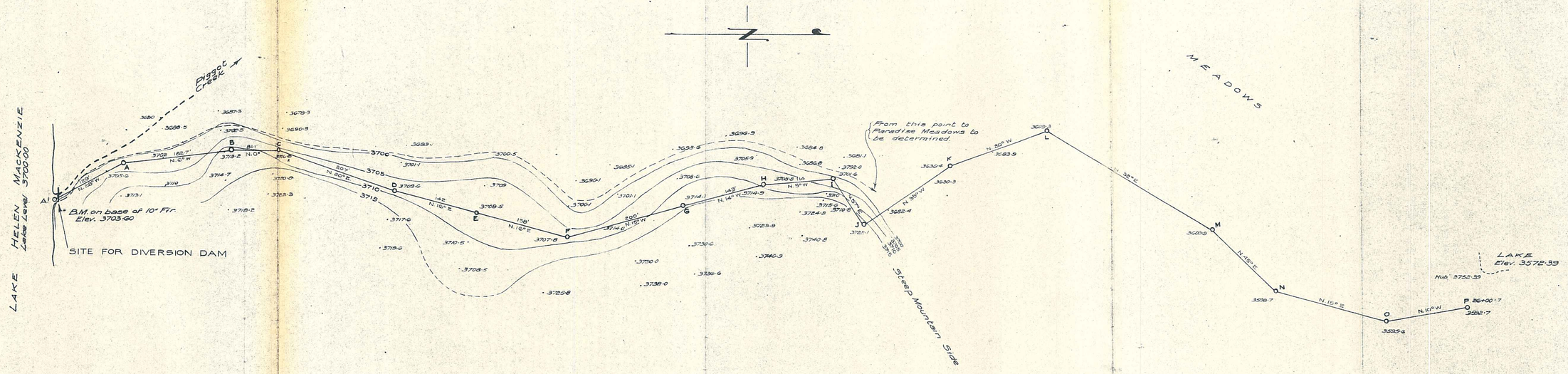
It would be extremely difficult to maintain any ditch or conduit line on the steep mountainside, and if it was constructed along the foot of the slope the line of the ditch would require to be carefully run from points "B" (end of present level) to point "C".

A considerable amount of field work is still required before final definate recommendations can be made and if the Council deem fit I shall be glad to discuss the matter with the Countil at their convenience.

Respectfully submitted.

(Signed by A.G. Graham)

Engineer.



BRITISH COLUMBIA
DEPARTMENT OF LANDS AND FORESTS
WATER RIGHTS BRANCH

WATER RESOURCES INVESTIGATION

To Accompany Report On

COMOX VALLEY WATER SUPPLY

PROPOSED DIVERSION OF CREEK AT LAKE HELEN MACKENZIE

SCALE: 100 Ft = 1 In.	DATE. AUG. 1958

.....ENGINEER

FILE NO. DWG. NO.

"E"

C O P Y

REPORT ON
LAKE HELEN McKENZIE DIVERSION
AND BROWNS RIVER WATERSHED
WITH SHORT SECTION ON
SUPPLY AND DISTRIBUTION SYSTEM

for

CITY OF COURTENAY

August 20th, 1947

F.C. Stewart

Telephone Office: Pacific 3817
Residence: Bayview 3822 R

F R E D C. S T E W A R T

Consulting Engineer

1007 Dominion Bank Building
Vancouver, B.C.

August 20, 1947.

The Mayor,
and Members of the City Council,
Courtenay, B.C.

Sirs:

Last March you instructed me to investigate, as soon as ground and weather conditions permitted, the possibility of using Helen McKenzie Lake as a storage reservoir for your water supply and if that did not prove feasible, to advise in the matter of "getting greater volume of water from the other lakes on which we have water rights". You supplied a topographical map, similar to that included herewith, and aerial photographs which were most useful in our work.

Before going into the field, these photographs and maps were carefully studied, and I had a talk with Mr. Cleveland, who reported on your water system in October, 1940, and who was good enough to lend me a copy of that report and to go over with me those portions dealing with the source of supply and all matters which might assist in my work. It is to be noted in his report, which covered a very broad field in a general way, that his examination of the Helen McKenzie Lake area was made in a few hours, and that to him the country between the lake and Paradise Meadow seemed "favourable for a ditch but an actual survey is required with some detailed examination of the nature and depth of the soil and proximity of bed rock to the surface, to indicate the ease or difficulty with which

the diversion of water might be made". In my interview with Mr. Cleveland he stressed the latter point and it was this detailed examination which was one of the major purposes of my work.

With this information I proceeded to Courtenay on August 6th, and found on arrival that a plan had meanwhile been received from Mr. A.G. Graham showing a survey line running north from the outlet of Helen McKenzie Lake for a distance of about half mile. This was also examined and made use of. With all this information and after examination of the intake, supply line, and water requirements I went into the Forbidden Plateau early in the morning of August 8th, ably assisted by your Superintendent, Mr. Jack Larsen. The nature of our investigation, observations, and conclusions are described briefly in the following pages:

SOURCE OF SUPPLY

Route and Area Covered: In order to gain first hand knowledge of the lakes in your watershed, for purposes of comparison with the Helen McKenzie Lake proposition, we left the Beecher trail on our way in, at McKenzie Lake and followed the route shown in black dashed line on the map and marked "Aug.8". As will be seen, this took us to Douglas, McKenzie, Pearse and Netuts Lakes, passed Johnson Lake on our left, and followed the connecting creeks for a distance of about two miles. It is interesting to note that in all this distance, after leaving the immediate vicinity of McKenzie Lake, no evidence or trace of humans was observed until the trail was reached again at Panther Lake. That night was spent at Mariwood Camp and the following day the Helen McKenzie Lake, Paradise Meadow, Battleship Lake area was examined. The route followed is shown on the map and marked "Aug.9". The next day we returned to the lodge and thence to Courtenay.

Helen McKenzie Lake Diversion: The stream leaving Helen McKenzie Lake flows over a solid rock bed, partly covered by loose rocks, and drops at a grade of only about 2½% to the top of a fall or rapids about 160 feet from the lake. The lake seems to be quite deep in the centre but is very shallow near the shore. It was estimated that, in the line of the outlet stream, the water depth was not over 3 feet at a distance of about 100 feet from shore, at which point the bottom seemed to drop off quite rapidly. It is believed that the cheapest all-round method of creating usuable storage would by by trenching into the rock, but

the overall length of such trench would be about 300 feet, at a depth of 8 feet below present lake water level. From the lake north, for about a third of a mile, we followed the approximate line of a diversion ditch, using hand level and referring to the Graham survey line over which levels had been run. The country is timbered but there is little underbrush. The side hill slopes west at angles observed to range generally from 12 to 20 degrees. The soil is reddish in color and fairly tight but close examination showed solid rock to be only a few inches below the surface over very much of the length, and , it is believed, the soil cover is not where deep for a length of nearly three quarters of a mile from the lake north. In one place, about 1/4 mile north of the lake, is a solid rock bluff, only a small area of which is bare but which was traced a considerable distance in both directions at very shallow depth. A few hundred feet beyond this bluff we turned west to examine the meadow. It is the usual grass covered, wet, black muck common in these areas, and is too low for our purpose. From here we travelled north, up and around the side hill to Paradise Meadow.

The elevation of the draw just south of Paradise Meadow may not be suitable for a diversion ditch. It was originally intended to check this accurately but it was concluded, after careful examination of the nature of the ground, that the cost of a ditch would in any case, be prohibitive and therefore that further investigation was unwarranted. It is true that the lake is large, and the water cooler than in the lower lakes but it is felt those latter latter lakes and their watershed offer something more within reach of the City and may, as pointed out by Mr. Cleveland, be developed to supply all requirements for many years to come. It is recommended therefore that the Helen McKenzie Lake diversion proposition be abandoned and that all attention be focused on the development of the present watershed.

Present Watershed:

By "present watershed" is meant the natural watershed of Browns River, for which Courtenay takes its water, in contrast to the Helen McKenzie Lake area which drains naturally to Oyster River. Browns River watershed above the intake has an area of approximately 33 square miles, is timbered, though in much of the area the soil cover is not deep, and in the portions we visited are many lakes and swamps. These swamps tend to hold the water and drain out slowly,

thus increasing the dry weather flow of the streams. The lakes provide means of artifically accomplishing the same purpose.

Adequacy of watershed: The streams are not glacier fed but our observations would indicate that a fairly good dry weather flow could be expected, though of course such flows are always relatively very small. It is significant that the small dam built at McKenzie Lake in 1931 has seldom, if ever, been opened to augment the natural flow of the river. No gauging has been done on this stream. With exception of the Punledge River, on which there is considerable regulation, the nearest streams of which flow records are available are the Campbell and Stamp Rivers. The minimum flow of Campbell River in the last 32 years was at the rate of 151 M.G.D. (million gallons per day) from an area of 542 square miles or 0.28 M.G.D. per square mile. The average flow in the driest year was equivalent to 1290 M.G.D. or 2.37 M.G.D. per square mile. Stamp River records are available for the period 1913 to 1931 and from 1940 to date. In that time, the minimum flow was 48 M.G.D. from an area of 336 square miles, or 0.14 M.G.D. per square mile. The average flow in the driest year was equivalent to 875 M.G.D. or 2.6 M.G.D. per square mile. The average flow of the Puntledge in the driest year from 1913 to date was equivalent to 360 M.G.D. from an area of 175 square miles or 2.06 M.G.D. per square mile. This figure should be correct but the minimum recorded flow is of no value as the stream is regulated by dams.

Minimum flows are extremely difficult to estimate, but from the preceding paragraph it would not seem unreasonable to expect a minimum of approximately 0.10 M.G.D. per square mile or 3.3 M.G.D. from the Browns River watershed, which is more than your new supply line will handle. This figure may be entirely wrong but it is safe to say that you can operate in all but the driest weeks of the driest years without regulation. Average run-off over the driest year equivalent to 60 or 65 M.G.D. may be expected. This is obviously many times more than you will ever require. It is clear therefore that Browns River Watershed is more than ample for your purpose. Furthermore, your present requirements, or even the capacity of the supply line now under construction, is so small relative to the yield of the watershed that it is difficult to picture a summer in which any appreciable draw from storage would be required for more than a few weeks.

Storage: Some regulation of stream flow to augment the natural run-off in

prolonged dry spells may be provided by controlled storage in Pearse Lake and other lakes which drain to and through it, as described in the Cleveland report. It should be noted also that there may be good dam sites at other points in the area which could be used to create still greater storage. In our trip no such sites were located but further examination which could be carried out more easily when the City has a construction camp in the vicinity would be well worth while. By this method of control, the water is simply turned into the stream as required, to find its own way to the intake. Some fear has been expressed that there may be great loss into the ground. In our journey up the creeks in this area the proximity of solid rock to the surface was most noticeable, and an appreciable proportion of the streams beds are in solid rock. Loss into the soil should therefore not be great. There is also a good forest cover which would tend to limit evaporation losses. The greatest difficulty lies in regulating the openings to give the required flow without wastage over the intake dam where the forebay is small or almost negligible, as yours is. It is felt that this may be improved, when required, by a stop-log arrangement as mentioned by Mr. Cleveland, or even by flash boards on the dam crest.

From observations on the ground, and a study of the topographical map, it seems safe to say that in Pearse Lake and the watershed above it, sufficient storage may be created at reasonable cost to provide ample water for your City and district for a great many years to come, and that the layout has the distinct advantage of lending itself to progressive development.

McKenzie Lake: The program of lake storage was actually commenced in 1931 when a dam was built at the outlet of McKenzie Lake. This was examined and measured up sufficiently to prepare the sketch, Fig.1 The dam is a braced vertical log structure with a control gate about 18" square, the bottom of which is 4' - 4" below the spillway lip. The gate spindle extends to the surface and is operated by a wrench. The assembly, and outlet opening, are in a concrete block or buttress, into which the logs are sealed on either side. The timber seems quite good but there is a leak around the end at "A" where the earth has been scoured away from behind the well. This is large enough that it will not seal itself but is more likely to increase. It is said that the timber wall is sealed into solid rock at the base but this could not be seen as loose rock covers the stream bed.

The logs were not carried into the bank quite far enough to be

safe. To extend that now would require the lowering of the lake but it could probably be made safe by caulking the leaks, placing a rock fill behind the wall and against the bank, grading downstream from very fine to course and faced with heavy rocks; and re-puddling and increasing the earth fill on the water side at this point. This should be done in the very near future. At the same time, it would be advisable to strengthen the other endin a similar manner and carefully inspect the entire structure. The bed should also be examind, particularly as to bottom seal and depth to solid rock.

From the sketch it may be seen that the bottom of the gate opening is 4' - 4" below the spillway lip, so that with a depth of flow of 6" through the gate (and less would be little use) then there is 3' - 10" available storage, which in the area of 27 acres, means 28 million gallons. The creek banks at the dam are high enough that this quantity could be doubled by a higher dam. It is suggested that the present dam be repaired but otherwise left as is for the time being.

Douglas Lake: Douglas Lake drains into McKenzie Lake, is only about 5 feet higher than the latter and less than 100 feet distant. The outlet stream is in solid rock with profile as shown, Fig.2.

It could be lowered about 2 feet by a trench in rock of average length approximately 65 feet and raised about 2 feet by a log dam, bolted and sealed to the rock. Such a low dam would require little margin clearing. Storage to a depth of 3 feet would be about 15 million gallons. This might be done as the next step after Pearse Lake.

Pearse Lake: This lake, with a surface area of about 24 acres, lies $\frac{1}{2}$ mile down stream from McKenzie Lake. Through it pass all the waters of the group of lakes in this area. The outlet is in solid rock with profile as shown in the sketch, Fig.3

As in all cases, the submerged portion is estimated only, as we had no means of taking soundings. The remainder was actually measured by tape and hand level. The water surface could be raised only a foot or so as the stream banks are low. Much marginal clearing would also be required,

Raising of the water level is therefore not proposed. Rather, it is recommended that use be made of the existing storage by excavating a trench in the rock about 3 feet wide and constructing therein a concrete plug with sliding gate.

The depth of storage which could be obtained efficiently is this way can only be told after soundings are made in the lake, but it is believed that at least 6 feet is quite possible. This would control approximately 27 million gallons of storage. The development of this lake is recommended as the next step in the program as it would not be very expensive, would be safe and being nearest to the intake, would provide thebest control. Unfortunately in our preliminary inspection we were unable to make a complete surveys, but two days in camp at the site, or at McKenzie Lake should be sufficient to complete this survey, design and lay out the work. That sould be done a week or so before commencement of construction.

Netuts Lake: The outlet of this lake is much like that of Pearse except that the creek bed is nearly level for over 100 feet from the lake and then drops off. Here too a trench in rock seems best suited. That might be done, as required, after Pearse or Douglas Lake.

Johnson Lake: Has not examined in detail, but is described in the Cleveland report.

Battleship Lake: Differs from the others in that there is a quite extensive meadow immediately below the outlet. Development would be more expensive than in the Pearse Lake group and should therefore be left till the last.

Summary of Findings:

1. Helen McKenzie Lake diversion ditch would be very expensive due to nature of grounds and location, and is therefore not recommended.
2. Browns River watershed is ample for your purpose and attention should be concentrated on the provision of storage in Pearse Lake and in the area tributary to it, though storage would likely be required only a few weeks in the driest years.

Proposed Program:

1. Repair McKenzie Lake dam.
2. Control Pearse Lake storage by a trench in rock with concrete plug and gate.
3. Provide some storage at intake by some type of moveable dam or flash boards.

4. Develop other lakes in the Pearse watershed as required.

5. While in the area (Pearse Lake watershed) investigate possibility of obtaining inexpensive storage by damming one of the streams.

SUPPLY LINE AND DISTRIBUTION SYSTEM

Supply Line:

Your supply line construction was visited, as was also the intake and settling tank. Some details of the intake were noted and, as we could find no information on the settling tank, levels were run from the dam to the tank. It was found that the tank overflow is 3 ft. below the dam crest and that there is about 1450 feet of 16" concrete pipe from the dam to the tank. According to the profile, there will be about 15,400 feet of 12" concrete pipe from the settling tank to the reservoir, with a fall in water surface of 73 ft. or 4.74 ft. per thousand. This line should be capable of carrying 1.5 million gallons per day. With a daily consumption at that rate, an hourly peak rate of about 2.2.M.G.D. would be expected, the additional water being supplied from the reservoir.

According to Mr. Larsen, it is the intention to construct a larger settling tank immediately downstream from the present tank, and to provide better screening facilities. There can be no question of the need of this improvement. Larger screen area with double screens and cleaning arrangements are required, as well as larger settling tanks, so arranged that they can be cleaned without shutting down the line. Sufficient data was obtained on the ground for the design of that layout when required.

The intake arrangement is unfortunate in that the inlet is in the back eddy and so catches more debris than it sould, and the bottom is filling with sand and gravel. The face of the chamber which is parallel with the stream would seem a much better place for inlet openings. Cleaning of the screen is also difficult. I could not see inside the chamber, but it should be possible to arrange a trash rock in front of the 16" pipe inlet which could be easily rakes. That, in conjunction with dual fine screens at the settling tank should make quite an efficient layout.

Distribution System:

One afternoon was spent with Mr. Larsen on the distribution system. It is understood that practically all pipes are wood stave and will soon require replacement. The City system consists essentially of one main down 5th St. with smaller pipes, generally 4" branching off it. There are many dead ends, and little attention has been paid to looping. As is generally understood, the system is inadequate and has no flexibilty.

From our hurried examination, it would seem advisable to relay the line from the reservoir to Willemar Ave. in permanent pipe of larger diameter, probably 16" ✱. At that point, ie. Willemar and 10th St., divide into two branches, one north to 5th and down 5th St., the other south to 14th., down 14th to Cumberland Road, Cumberland Rd. to 13th. and 13th to Cliffe Ave. The loop, probably 12" would be completed by a pipe on Cliffe Ave. The smaller pipes, as on McPhee, Louis, etc. would be connected with both main arteries. If the 13th St. line were laid first, the 5th St. pipe could be replaced with much less inconvenience. As the City grows south a third loop would be added about 19th or 20th St. That loop would be smaller than the others as it would supply only residential areas where fire demand is much less than in the business district.

The dimensions suggested are tentative only and cannot be accurately determined due to lack of topography. It would be a simple matter to take spot levels at such intersection, and it is suggested that that be done. Pipe requirements could then be accurately determined and such levels would also be useful for other purposes.

In general the use of 4" pipes in the grids is poor practice, where full fire protection is desired. Six inch is the smallest size recommended, though some 4" may be used in small loops and where there are no hydrants. It is noted that you are commencing to use cast iron pipe in your distribution system. This is to be commended.

✱ 18" installed.

The Comox feeder, being only 4" diameter is small for any purpose and is entirely inadequate for fire protection, either in Comox or along the waterfront in Courtenay itself. In this problem, storage in or near Comox, pumping, and dimensions of main are all involved and information at my disposal at the moment is not sufficiently complete to say just what would be the most efficient layout. This should be gone into properly when the time comes. In the meantime, it does seem that, if fire protection is desired along Comox Rd., the pipe should not be smaller than 8 inch.

It is assumed that all are familiar with the contents of Mr. Cleveland's report, and many points such as possible contamination and watershed protection are not repeated here.

This report has mentioned many requirements, the total cost of which would be considerable. Fortunately however there seems no need of carrying out any great amount of work at one time. All schemes may be developed in stages, so that, if a general plan is laid down and followed, improvements and extensions may be made as required with the knowledge that eventually all will fit together to form a smooth operating, flexible system of adequate capacity.

Respectfully submitted

(signed) F.C. Stewart, R.P.E.

August 20th, 1947.

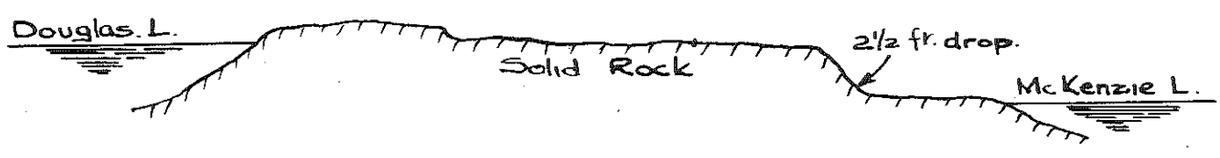


Figure 2.

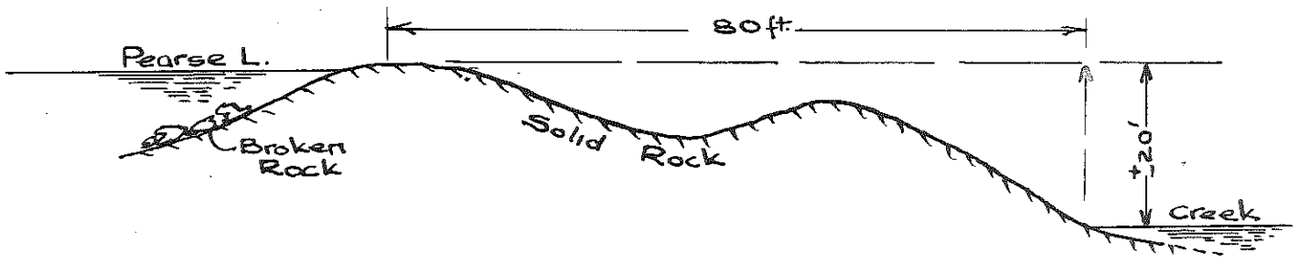


Figure 3.

APPENDIX "F"

COST OF PROJECT "A"

(GRAVITY SUPPLY FROM BROWNS RIVER).

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	ACCUMULATED TOTAL
	STORAGE RESERVOIRS					
1.	Earth Embankment for 20' high dam at MacKenzie Lake outlet	1700	c.y.	2.00	3,400.00	
2.	Concrete spillway for MacKenzie Lake				700.00	
3.	Outlet and control gate and culvert, MacKenzie Lake				1,500.00	
4.	Trench in rock from Douglas Lake to MacKenzie Lake, 3'x4' deep	35	c.y.	12.00	400.00	
5.	Marginal clearing to MacKenzie and Douglas Lakes.	30	acres	500.00	15,000.00	
	TOTAL COST - MacKenzie and Douglas Lakes storages.				21,000.00	21,000.00
	Cost per acre ft. storage is $\frac{21,020}{666 + 175} = \$25.00$					
6.	Trench in rock at Pearse Lake outlet 3' x 9' x 100	100	c.y.	12.00	1,200.00	
7.	Concrete Plug and control gate. Allow.				800.00	
	Cost per acre ft. of storage is $\frac{2000}{251} = \$8.00$				2,000.00	23,000.00
8.	Trench in rock outlet to Netuts L. 3' x 6' deep x 150'	100	c.y.	12.00	1,200.00	
9.	Concrete plug and control gate. Allow.				800.00	
	Cost per acre ft. storage - $\frac{2000}{78} = \$25.60$				2,000.00	25,000.00
10.	Log dam 10' high by 60' long at outlet to Johnson Lake plus control gate. Allow.				3,000.00	
11.	Marginal clearing to Johnson Lake.	12	acres	500.00	6,000.00	34,000.00
	$\frac{9000}{246} = \$36.60$				9,000.00	

APPENDIX "F" - con'd

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	COST	ACCUMULA TOTAL
	Total Headwater storage					$ 34,000
	Average cost per acre foot storage - $\frac{34,000}{1416} = \$24.00$					
12.	Access Road to Plateau and storage reservoirs	12.00	miles	30.00	36,000.00	70,000.0
	INTAKE DAM					
13.	Construction of dam and intake				8,000.00	78,000.00
	MAIN PIPE LINE (Intake to Point B)					
14.	24" steel pipe line and coupling from dam to Point A. (Co-ordinates - 5,000 & 247,000)	29,400	lin.ft.	15.75	463,050.00	
15.	Laying & Jointing to item 14	29,400	Lin.ft.	0.36	10,584.00	
16.	Excav. & backfill item 14	29,400	lin.ft.	0.90	26,460.00	
					500,094.00	578,094.00
	TREATMENT					
17.	Chlorination equipment and chlorination house. Allow.				20,000.00	598,094.00
	MAIN PIPE LINE THROUGH NORTH AREA (A to D) and A TO COURTENAY RESERVOIR					
18.	16" dia. steel pipe and couplings (A to D) plus tie to Courtenay Reservoir	21,000	lin.ft.	10.65	223,650.00	
19.	Laying and Jointing to item 18		lin.ft.	0.24	5,040.00	
20.	Excavation and backfill to item 18		lin.ft.	0.90	18,900.00	
					247,590.00	845,684.00
	POINT F TO CUMBERLAND RESERVOIR					
21.	12" dia. steel pipe and couplings	10,000	lin.ft.	8.48	84,800.00	
22.	Laying and jointing item 21	10,000	lin.ft.	0.18	1,800.00	
23.	Laying and jointing item 21	10,000	lin.ft.	0.70	7,000.00	
					93,600.00	939,284.00

ITEM	DESCRIPTION	QUALITY	UNIT	UNIT COST	COST	ACCUMULAT TOTAL
	Total brought forward					939,284.00
	SOUTH MAIN POINT C TO POINT F					
24.	16" Dia. steel pipe (Pt. A to B-Courtenay)	22,000	lin.ft.	10.65	234,300	
25.	Laying and jointing item 24	22,000	lin.ft.	0.24	5,280	
26.	Excavation and backfill item 24	22,000	lin.ft.	0.90	19,800	
					259,380	1,198,664.00
27.	12" Dia. steel pipe (Pt. D to Comox Reservoir)	16,900	lin.ft.	8.48	143,312	
28.	Laying & jointing Item 27	16,900	lin.ft.	0.18	3,042	
29.	Excavation & backfill Item 27	16,900	lin.ft.	0.70	11,830	
					158,814	1,357,478.00
30.	8" Dia. steel pipe to complete Royston-Courtenay tie and couplings plus laying and jointing excavation and backfill	9,000	lin.ft.	5.00	45,000	1,402,478.00
	SERVICE RESERVOIRS					
31.	Reinf. concrete reservoirs 1/2 m.g. capacity Cumberland-Allow				47,000	
32.	Same for Comox				47,000	
33.	1 m.g. capacity for Courtenay				70,000	
					164,000	1,566,478.00
	ADD 15% FOR ENGINEERING AND CONTINGENCIES					234,522.00
						$1,801,000.00

Annual cost on basis of 5% interest, retirement of loan in 25 years, plus operating and administrating costs = 0.08 x 1,801,000 - 144,080.00

Chlorinating costs for treatment 1,000 million imperial gallons per year (use by 1983) 2,000.00

146,080.00

Wholesale cost of water per 1000 gallons in 1983 (not including distribution costs)

$= \frac{146,080}{1,000,000} =$ 14.6¢ per 1,000 gallons

COST OF PROJECT B

(GRAVITY SUPPLY FROM PUNTLEDGE RIVER AND ALLEN LAKE)

Item	Description	Quantity	Unit	Unit Cost	Cost $	Accumulation Total
	Intake Works - Puntledge River					
1.	Intake works, pipe, gate, valve house. Say				6,000.00	6,000.00
	Main Pipe Line (Dam to Pt.C)					
2.	24" Steel Pipe Line and couplings from intake to Pt.B	17,900	lin.ft.	15.75	281,925.00	
3.	Laying and jointing to Item 2	17,900	lin.ft.	0.36	6,444.00	
4.	Excavation and Backfill to Item 2	17,900	lin.ft.	0.90	16,110.00	
					304,479.00	310,479.00
	Treatment Plant					
5.	Chlorination equipment and Chlorinator House. Allow:				20,000.00	330,479.00
	North Main to Courtenay-Comox (C to D)					
6.	16" Steel pipe line and couplings Pt.B. to Pt.D	12,800	lin.ft.	10.65	136,320.00	
7.	Laying and jointing to Item 6	12,800	lin.ft.	0.24	3,072.00	
8.	Excavation and Backfill to item 6	12,800	lin.ft.	0.90	11,520.00	
					150,912.00	481.391.00
9.	12" Steel pipe line and couplings Pt.D to Comox	16,900	lin.ft.	8.48	143,312.00	
10.	Laying and jointing to Item 9	16,900	lin.ft.	0.18	3,042.00	
11.	Excavation and Backfill to Item 9	16,900	lin.ft.	0.70	11,830.00	
					158,184.00	639.575.00
	South Main to Cumberland (C.to 6)					
12.	16" Steel Pipeline and couplings Pt.B to Pt.G	8,000	lin.ft.	10.65	85,200.00	
13.	Laying and jointing to Item 12	8,000	lin.ft.	0.24	1,920.00	
14.	Excavation and Backfill to Item 12	8,000	lin.ft.	0.90	7,200.00	
					94,320	733,895.00

..2

PROJECT B

Item	Description	Quantity	Unit	Unit Cost	Cost $	Accumulation Total
					b.fwd.	733,895.00
Pt. G. to Cumberland						
15.	12" Steel Pipeline and couplings	20,500	lin.ft.	8.48	173,840.00	
16.	Laying and jointing to Item 15	20,500	lin.ft.	0.18	3,690.00	
17.	Excavation and Backfill to Item 15	20,500	lin.ft.	0.70	14,350.00	
					191,880.00	925,775.00
Main From Allen Lake to Cumberland						
18.	12" Steel Pipeline and Couplings	9,000	linft.	8.48	76,320.00	
19.	Laying and jointing to Item 18	9,000	lin.ft.	0.18	1,620.00	
20.	Excavation and Backfill to Item 18	9,000	lin.ft.	0.70	6,300.00	
					84,240.00	1,010,015.00
Completion of Courtenay-Royston Tie						
21.	8" Steel Pipe to Roysteon Courtenay, plus couplings, laying, jointing, excavation, and backfill	9,000	lin.ft.	5.00	45,000.00	1,055,015.00
Service Reservoir						
22.	Reinf. Concrete 2.M.G. Reservoir-Courtenay				120,000.00	
23.	Reinf. Concrete ½ M.G. Reservoir-Comox				47,000.00	
					167,000.00	1,222.015.00
Storage Reservoir						
24.	Development of storage Allen Lake	1,000	Ac.ft.	25,00	25.000.00	1,247,015.00
	Add 15% for Engineering-Contingencies					187,085.00
						1,434,100.00
					Say:	1,434,000

Annual Costs

Operation and Maintenance at 8%	114,720.00
Chlorination Costs	2,000.00
	116,720.00

Cost per 1000 gallons (in 1983) for 1000 mg.per year ..... = 11.7¢