Province of
British Columbia

Ministry of
Environment

Lower Mainland Region
10334—152A Street
Surrey
British Columbia
V3R 7P8
Telephone: 584-8822

FILE: 2-0058

April 18, 1983

MINISTRY
OF ENVIRONMENT

APR 21 1983

Water Management Branch
Victoria, B.C.

Water Management Branch,
818 Fort Street,
Victoria, B.C.
V8V 1X5

ATTENTION: P. M. Brady, Comptroller of Water Rights

Dear Sir:

RE: Water Licence Application: Freil Lake

Regional Water Management staff have reviewed the hydrologic information submitted by Mr. C. A. Beach in support of the subject Water Licence Application. In summary, we found that both the methods used and the results reached are of questionable reliability. Considering the large scale of the proposed project, we recommend that a more detailed study be undertaken. It should provide a better insight to the hydrologic characteristics of the watershed and should include some field measurements of streamflow.

Following are some comments on the technical aspects of Mr. Beach's submission:

1) There is a definite lack of streamflow data in this area, however, there are some Water Survey of Canada stations that could be used in addition to Lois River and Earle Cree. These include:

   - Lang Creek near Powell River
   - Theodosia River near Bliss Landing
   - Sliammon Creek near Powell River
   - Chapman Creek above Sechelt Diversion

   The Lois River watershed is approximately 30 times as large as the Freil Lake Watershed, so its use as an accurate streamflow indicator is questionable.

. 2

Mr Webber
see April 22/83

2) One year of regulated data was included in the mean flow of Lois River. This unnecessarily reduced the estimate streamflow.

3) The use of 0.80 as a coefficient of runoff is unjustified.

4) The estimated mean annual total precipitation for Freil Lake, should be verified. There is some "Provincial" data available that has not been used.

5) The figures used in the June - September 7-day average low flow estimation for Lois River include two years of regulated data for which the flow was zero. These figures should have been ignored. This would increase the 7-day low flow estimate for Freil Lake.

6) The tabulated "Annual Available Volume" is really the mean total annual flow volume. The estimation of 19,000 acre feet for Freil Lake appears to be reasonable considering the low level of base data used. By applying for 19,000 acre feet per annum, the applicant is requesting the total mean flow of the creek.

In summary, it is not clear who has actually done the work submitted by Mr. Beach. It appears that it has been prepared "in consultation with Mr. P. J. (Peter) Kluczynski, P. Eng.", but not, necessarily by him. We feel that the above issues should be resolved before further processing of this application.

Yours truly,

J. W. McCracken, P. Eng.,
Regional Water Manager,
Lower Mainland Region.

JWM/gb

Enclosure

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: Mr. C.H. Coulson,
Head,
Surface Water Section,
Water Management Branch.

Date: April 25, 1983

File: WA-16(g)
20058

Re: Water Licence Application by Coast Mountain Aquasource Canada Company, C.A. Beach;
Freil Lake, Hotham Sound

Mr. Colin A. Beach representing the above referenced company has filed an application for a water licence for storage and diversion of water from Freil Lake, Hotham Sound. The quantity of water applied for is 19,000 acre feet per annum, and the purpose is the export of water by tanker ship and/or containers. Attached hereto is a general description of the concept prepared by C.A. Beach (Appendix 'A').

Due to the size and implications of the proposed water use, the processing of this application is being co-ordinated by the Comptroller's staff in Victoria.

Attached as Appendix 'B' is a hydrology report on Freil Lake submitted by C.A. Beach in support of the application, and a memorandum from the Regional Water Manager commenting thereon. It would be appreciated if you will review this material and let me have the following:-

(a) your independent critical appraisal of the C.A. Beach hydrology report; and

(b) the terms of reference which we should require C.A. Beach to convey to his professional consultant for the completion of a detailed hydrologic study and report which could be reliably used in arriving at a licensing decision.

Currently, there are no existing water licences on Freil Lake.

J.E. Farrell,
Deputy Comptroller of Water Rights.

Attachments.

Mr Rekstan

830425

Appendix 'A'

Coast Mountain Aquasource

Fresh water export project
from proposed source at
Freil Lake, Hotham Sound

Physical description of the source location

The site is located approximately 55 miles northwest of Vancouver, B.C. The lake is located at approximately 1,500 foot elevation on a largely uninhabited peninsula on the east side of Hotham Sound, Jervis Inlet. Freil Lake is drained by an unnamed creek which flows south west approximately horizontal for 200 metres, after which it descends steeply via two major cascades and two areas of steep creek into the ocean. The final cascade terminates at an elevation of approximately 150 feet above sea level. From this point the water diverges into a myriad of uncontrolled flows over massive moss-covered fragmented fallen conifers and boulders. The water finds its way to the ocean over a width of approximately 100 metres.

Description of the proposed works

1. Concrete dam (approximately 7'6" high by 30' long) built at the outflow from the lake. This would not be visible from Hotham Sound.

2. Concrete catchment basin (approximately 80' long by 40' broad by maximum 25' high) built centred on the natural drainage at the bottom of the final cascade of the waterfall at an elevation of approximately 150 feet. This structure would only be partially visible, if visible at all, from Hotham Sound.

3. Penstock (pipe) 30 inch diameter installed from the catchment basin location to the seashore. This would be installed on concrete supports at approximately 4 feet from ground level. This pipe would not be visible from Hotham Sound.

4. Concrete housing and abutment at high tide level on the waterfront. Nominal dimensions: 12 feet by 60 feet in plan, maximum height of 30 feet.

. . . / Page 2

Coast Mountain Aquasource

Fresh water export project
from proposed source at
Freil Lake, Hotham Sound

5. Prefabricated floating concrete docking facility, 128 feet long by 12 feet wide, including an additional two sections of 12 feet wide by 16 feet long integrally constructed to the seaward end of the dock. This structure would contain the penstock, which would therefore be invisible to the public. This custom-manufactured docking facility would be provided with hardware to allow recreational boaters to secure their vessels to its sides.

6. Installation of two steel mooring buoys and shore bollards.

Explanation of the works described

The purpose of the small dam at the outflow of the lake is to allow a controlled flow of the available water from the Freil Lake drainage area. A floodgate would be provided at the dam which would allow the operator to increase the flow at the time of loading a vessel. This system is required in order to permit as firm a schedule of deliveries as possible to be achieved. Once the maximum storage level of the dam is achieved (7'0") the waterfall flow would continue in its usual fashion. When a vessel is in position to be loaded the floodgate in the dam would be opened, allowing the vessel to be rapidly loaded to depart on its voyage. The water released from the dam would follow the natural course of the water fall to the catchment basin described in no. 2 above. The catchment basin simply provides a means of collecting the available water and feeding it by gravity through the penstock to the vessel. The concrete housing and abutment is required to provide a means of securing the floating dock to the shore and to contain a flexible connection in the penstock. The floating docking facility would serve as a means of supporting the penstock and positioning the vessel to be loaded, as well as providing a place for recreational boaters to tie up. The two steel mooring bouys would be required to secure the vessel seaward from the floating dock, while the shore bollards are required

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Coast Mountain Aquasource

Fresh water export project
from proposed source at
Freil Lake, Hotham Sound

as retainers for submerged lines or chains to the seaward end of the floating dock, the mooring bouy anchor blocks, and to receive lines from the vessel to be located.

Statement of the benefits of the proposed project to the people of British Columbia and to the residents of both the Sunshine Coast and Powell River Regional Districts

1. The granting of a Water Licence would mean revenue to the provincial government for a resource from which none is presently being received.
2. Further revenue would accrue to the provincial government for the use of the foreshore and land required for the project.
3. The construction phase of the project, preliminary estimates for which are in the one million dollar range, would provide contracts and jobs for many people, and income tax revenue.
4. The operation of the project would provide on-going jobs for additional personnel, including a contract for the positioning of vessels, and further tax revenue.
5. Rezoning of some of the required land to an industrial use application is probable; this would mean revenue to the Sunshine Coast Regional District.
6. The proposed floating concrete dock facility would be available for use by recreational boaters.
7. Persons fortunate enough to be in viewing range of the site at the time of loading a vessel would be treated to a "waterfall show". In the summer and early autumn, there is not usually a flow of great volume over the falls, and this is the time when the area is frequented most by boaters. The proposed loading design would allow a volume of mid-winter or spring run-off condition to come over the falls in the middle of summer. The scheme therefore has considerable tourist attraction potential.

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Coast Mountain Aquasource

Fresh water export project
from proposed source at
Freil Lake, Hotham Sound

Statement of project benefits (continued)

7. (cont'.) Market research is being carried on to supply water to clients in California. If deliveries of water from Freil Lake were ultimately made to that area, the source would become known to the recipients, and this would encourage them to visit the area. Hence, there is additional potential for attracting tourists, and thereby increasing local business.

8. The construction of the catchment basin and the installation of the penstock from the basin to the seashore would require earthworks and landscaping. This area, presently in the dangerous condition described under the title "Physical description of the source location" at the beginning of this presentation, would be made safe for pedestrian traffic.

   For reference, you will find enclosed a copy of a letter from Mr. Lloyd Brooks, Deputy Minister, Department of Recreation and Conservation, dated December 13, 1972, to Mr. D. Borthwick, Deputy Minister, Department of Lands, Forest and Water Resources. Mr. Brooks has recognized the beauty of the falls, but indicates reluctance to create parks at such sites because of their dangerous conditions.

   With specific reference to Freil Falls, Mr. Brooks mentions that they can be viewed by passengers on the Earl's Cove - Saltery Bay ferry. At the distance the ferry passes, it is doubtful that any of the proposed works would be visible to the naked eye. However, during the periods of low rainfall, a passenger on the ferry would certainly be able to see the "waterfall show" at the time of loading.

   The natural appearance of the site would be maintained as it would not be necessary to remove healthy standing trees, except as necessary for a 20 wide access from shore. It is likely that all tree cutting can be avoided.

Appendix 'B'

January 11, 1983 File 2-58

June - September, 7 day average, low flows from Freil Lake extrapolated from records at Station No. 086B003, Lois River below Scanlon Dam

Drainage area of Lois River	456 km.^{2}	112,691 acres
Drainage area of Freil Lake	15.76 km.^{2}	3,894 acres

WSC Lois River mean a.ro = 1633 mm.

Calculated average annual total precipitation over the total drainage area of Lois River, assuming a run-off coefficient of 0.80 is 1841 mm. what is RO estimate? RO = 1.2-3

Estimated average annual precipitation over Freil Lake drainage area is 1860 mm. based on ?

Calculation of extrapolation coefficient:

$$\frac{\text{Freil Lake drainage}}{\text{Lois River drainage}} \times \frac{\text{Freil Lake total precip.}}{\text{Lois River total precip.}}$$

$$\frac{15.76}{456} \times \frac{1860}{1841} = 0.0349$$

Check on coefficient: ?

Mean Lois River flow is 752.21 C.F.S. ?
Mean Freil Lake drainage area flow is
752.21 x 0.0349 = 26.26 C.F.S.

Recorded flows at Station 086B003, Lois River below Scanlon Dam		Extrapolated flows at Freil Lake
June - September, 7 day average, low flows		
324 C.F.S.	August 16, 1921	11.31 C.F.S.
165 C.F.S.	August 3, 1922	5.76 C.F.S.
118	August 18, 1923	4.12
100	Sept. 13, 1924	3.49
132	August 19, 1925	4.61
42	August 27, 1926	1.47
151	August 19, 1927	5.27
52.4	Sept. 9, 1928	1.83
66.3	Sept. 27, 1929	2.31
0	August 21, 1942	0
0 C.F.S.	August 15, 1943	0

Mean flow: 3.652 C.F.S.

January 11, 1983 File 2-58

Second Determination of Mean Annual Available Water from the Drainage Area of Freil Lake

The method is to average two extrapolated mean annual volumes computed for the Freil Lake drainage as follows:

1. Based on records for Lois River below Scanlon dam:

Available mean annual volume at Lois River below Scanlon Dam	x	Freil Lake drainage area / Lois River drainage area	=	Mean annual available volume at Freil Lake drainage area
544,575 acre feet	x	15.76 km.^{2} / 456 km.^{2}	=	18,821 acre feet

619 ✓

2. Based on records for Earle Creek:

Available mean annual volume at Earle Creek	x	Freil Lake drain. / Earle Creek drainage area	=	Mean annual available volume at Freil Lake drainage area
29,661 acre feet	x	15.76 km.^{2} / 22.5 km.^{2}	=	20,776 acre feet

1.33 ✓

3. Therefore, mean annual available volume of water, based on the average of these two extrapolated mean annual available volumes at the Freil Lake drainage area, is:

$$\frac{18,821 + 20,776}{2} = 19,798.5 \text{ acre feet/annum}$$

4. Note: "It is the considered opinion of the consulting Engineer, Mr. P. J. (Peter) Kluczynski, P. Eng., that the existing total precipitation and river flow records at Lois River and Earle Creek are of sufficient duration to be considered as a data base for any hydraulic design project. No Freil Lake drainage area is located equidistant between Lois River and Earle Creek drainage areas. Topographical and climatic characteristics of these three areas are very similar. These conditions validate the above method as a reliable one for predicting the total annual available volume of water from the Freil Lake drainage. The volume of water applied for is less than the mean volume extrapolated. Any hydrological recording to determine actual total precipitation over Freil Lake drainage area and actual outflow from Freil Lake would need to be carried out for a minimum ? of seven years, which can not be justified."

January 11, 1983 File 2-58

First Determination of Mean Annual Available Water from the Drainage Area of Freil Lake

	Lois River Scanlon Dam nr. Powell R.	Earle Creek near Egmont	Clowhom Falls nr. Sechelt	Freil Lake
Mean Annual Total Precipitation	1941-70 1534 mm ✓ (*) 1608 mm. ✓ 1841 mm. (L1) 1951-80 1608 mm.	2000 mm. (E2)	2234 mm. ✓	1690 mm. (F1) 1860 mm. (F2)
Years of Record	1951 - 80 ✓	n/a	1951 - 80 ✓ mean	n/a
Single Climate Control Station at Elevation	Yes (*) 400' / 120 m.	No 0'-6100'	Yes 23m nr. sea level	No 1500'-4806'
Mean Annual Streamflow	21.3 m^3/sec. 752.2 C.F.S.	1.16 m^3/sec. 40.97 C.F.S.	n/a	(F4) 26.26 C.F.S.
Years of Record	1921-29, 43-47 9 year mean flow	5 year mean flow	n/a	n/a
Drainage Area	456 km^2 112,691 acres	22.5 km^2 5560.4 acres	n/a	15.76 km^2 3,894 acres
Coefficient of Runoff	0.916 (*)(L2) 0.80 (L3)	0.81 (E1)	n/a	0.80 (F3)
Available Annual Volume	544,575 acre feet 4.83'	29,661 acre feet 5.33'	n/a	19,002.72 acre feet (F5) 4.87'

Note:

1. Mean annual total precipitation not footnoted by letter and number, (e.g.: L1), has been obtained from the Climate Information Office of the federal government of Canada at 1200 W. 73rd, Vancouver, B.C., telephone: 732-4875.
2. Streamflow data not footnoted has been obtained from the Inland Waters Directorate of the federal government of Canada at 1001 W. Pender Street, Vancouver, B.C., tel.: 666-3610.
3. Footnoted total precipitation and streamflow values, drainage areas, and coefficients of runoff have been computed and/or selected in consultation with Mr. P. J. (Peter) Kluczynski, P. Eng.
4. Lois River and Earle Creek Available Annual Volumes computed by the Engineer. ← from WSC records
5. Please see the footnotes to the information conveyed in the table on the following page.

January 11, 1983 File 2-58

Footnotes to the Information Conveyed in the Table
"First Determination of Mean Annual Available
Water from the Drainage Area of Freil Lake"

* - Precipitation record for a single station only; therefore not representative of the whole Lois Lake drainage area

L1 - Representative mean annual precipitation total which, when combined with selected runoff coefficient of 0.80, yields streamflows virtually identical to those established by 9 year records for this area

L2 - Unrealistic runoff coefficient yielded by erroneous assumption that 1608 mm. total precip. figure was representative of the entire drainage area

L3 - Assumed realistic runoff coefficient

E1 - Assumed realistic runoff coefficient

E2 - Calculated total mean annual precipitation for Earle Creek drainage area using mean river flow record and assumed runoff coefficient

F1 - Detailed calculation based on data from map in the Atlas of British Columbia, published by U.B.C. Press, 1979; this figure appears to be an unreasonably low total precipitation value for this area when compared to data available for the nearest climate control stations, Lois River Dam and Clowhom Falls, both of which are at substantially lower elevation than any point in the Freil Lake drainage area

F2 - Selected by extrapolation from data for Lois River Dam and Clowhom Falls climate control stations, with reference to the Atlas of British Columbia

F3 - Selected as a reasonable coefficient of runoff with due consideration to topography, ground cover, soil types and the Lois River and Earle Creek area coefficients as per notes E1, L2, and L3, above

F4 - Based on F2 and F3 and planimetered drainage area calculation

F5 - Computation of available annual volume of water for the Freil Lake drainage to be rounded down to 19,000 acre feet per annum for the purposes of this application.

n/a - not available or not applicable.

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: D.E. Reksten
Senior Hydrological Engineer
Surface Water Section
Water Management Branch

Date: June 20, 1983

File: 0256957

Re: Freil Lake Report, Coast Mountain Aquasource

This memorandum is written in response to a request, dated April 25, 1983 from J.E. Farrell, Deputy Comptroller of Water Rights, for a review of a water licence application on Freil Lake. The proposed water licence is for 19,000 acre-feet (23 400 dam^3), which is estimated to be the mean annual volume runoff at the lake outlet. Although not presented in the text, it is estimated that the proposed lake storage with 7.5 feet as a maximum storage level is 4,310 acre-feet (5 320 dam^3). This figure should be confirmed by C. Beach or the consultant, P. Kluczynski.

In general all the points made by J. McCracken, Lower Mainland Regional Water Manager in his memorandum dated April 18, 1983 to P.M. Brady, Comptroller of Water Rights, are valid. To reiterate and emphasize several of the points made:

1. The method of "first determination" of mean annual volume runoff (available annual volume) for Freil Lake employed unsubstantiated estimates of basin precipitation and coefficients of runoff.
2. Both methods appear to assume that the mean annual volume runoff for 08GB003 Lois River and 08GB009 Earle Creek are long term means. These hydrometric stations in fact have only 9 and 5 years of complete record, respectively, and were not in operation the same years.
3. The procedure used to determine runoff coefficients by the comparison of mean annual volume runoff and mean annual total precipitation is incorrect, as the streamflow and precipitation records are not for concurrent periods.
4. Within the text it is stated that "topographic and climatic characteristics of these three areas," referring to 08GB003 Lois Lake, 08GB009 Earle Creek and Freil Lake, "are very similar." Aside from the differences in size, the basins were found to vary substantially in their median elevations and elevation ranges which should have a direct effect upon annual unit-runoff. Also it was noted that variation in precipitation for the study area becomes more pronounced when the 1951 to 1980 mean annual total precipitation is compared for two stations at the same elevation. These are, namely: 1047770 Stillwater Power House (approximately 4 kilometers from the Lois Lake Dam) and 1041710 Clowhow Falls with 1393 mm and 2234 mm of precipitation, respectively.

. . . 2

5. It is not clear what monthly inflows were used to calculate the reservoir refill times (p. 21-23 of complete report). It would not be correct to use the Lois River monthly distribution as there is too much upstream storage. The monthly distribution of runoff should be based on data for Earle Creek. The distribution used will make a large difference in recovery time especially for July and August. For example, it would take 120 hours (5 days) to refill in August after loading a 100,000 ton tanker rather than the 69.49 hours shown on p. 22.

6. Annual and monthly inflow calculations should be based on a low inflow year (e.g., 1969-70)and the reservoir live storage.

7. A design flood flow for the outlet structure has not been included.

Discussion

The estimated mean annual inflow of 19,000 acre-feet (23 400 dam^3) appears reasonable. A more rigorous regional analysis of the available data may give more reliable long-term estimates of Freil Lake inflow/outflow and expected peak flows. The critical low runoff months are July through September and if this application is to be seriously considered, a series of lake level observations and discharge measurements during this period is recommended.

Should you have any questions regarding this memorandum, please contact me directly.

Larry J Barr.

L.J. Barr
Technician
Surface Water Section
Water Management Branch
387-1111

LJB/DER/dma

J.E. Farrell
Deputy Comptroller of Water Rights
Ministry of Environment
818 Fort Street
BUILDINGS V8V 1X5

June 22, 1983

Re: Water License Application
Coast Mountain Aquasource Canada Co., C.A. Beach
Freil Lake, Hotham Sound

We have reviewed the hydrology aspects of this application report and the Regional Water Manager's comments. Mr. Barr's review comments are attached.

(a) Even with the sparse regional data available, a more rigorous, detailed analysis should have been carried out. However, the estimate of mean annual runoff is probably not unreasonable. Generally, with a large reservoir, the licensed quantity should be no more than 80% of the mean annual inflow.

(b) In general terms, a hydrologic study for a proposal such as this should include estimates of:

Monthly mean runoff or inflow
Return period (e.g., 10 year, 20 year) minimum monthly runoff
Return period peak flows

C.H. Coulson, Head
Surface Water Section
Water Management Branch
387-1111

Attach.
REKSTEN/dma

Coast Mountain Aquasource Ltd.
1248 Keith Road
West Vancouver, B.C.
Canada V7T 1M9
Telephone: (604) 926-5258 or 926-5184

Bulk supplies of fine quality potable water

September 26, 1983

Mr. Hal Coulson, P.Eng.
Head, Surface Water Section
Water Management Branch
Ministry of Environment
Parliament Buildings
Victoria, B.C. V8V 1X5

Dear Mr. Coulson:

Re: Water Management Branch Files WA-16g and 2000058
Revision of water availability figures, Freil Lake

Please note two errors on the information I submitted to you on September 20, 1983.

On page 1 (Sept. 19, 1983, CALCULATION OF MEAN ANNUAL AND MONTHLY FLOWS FROM FREIL LAKE), the period of record should read "1922 through 1929".

Similarly, on page 6, the years of the period of record should read "1922-1929".

Many thanks to Mr. Reksten, Mr. Barr, and to you for your continuing assistance.

I look forward to receiving your estimates for the twenty year low flow for the Freil Lake watershed and an estimate of the maximum peak daily flows (50 year return).

Sincerely,

Colin A. Beach
President

CB/sg

Mr Reksten DER 83-09-30
Barr LJB 83-10-03

L 830929

COAST MOUNTAIN AQUASOURCE LTD. September 19, 1983

Freil Lake Bulk Fresh Water Export Proposal
Colin A. Beach
Water Management Branch Files 2000058 and WA-16g

Data base: Lois River below Scanlon Dam, Station 08GB003
Period of record: 1922 through 1922, prior to the construction of the dam.

Lois River drainage area = 456 km.^{2} = 112,691.28 acres

Freil Lake drainage area = 3,894 acres

Ratio of drainage areas = 0.03455

1 cubic metre = 35.315 cubic feet

CALCULATION OF MEAN ANNUAL AND MONTHLY FLOWS FROM FREIL LAKE

MONTH	LOIS RIVER CU. METRES/SEC.	LOIS R. C.F.S.	FREIL LAKE C.F.S.	FREIL L. ACRE FEET
January	32.6	1151.3	39.8	2447
February	29.0	1024.1	35.4	1966
March	19.9	702.8	24.3	1494
April	22.0	776.9	26.8	1595
May	33.1	1168.9	40.4	2484
June	25.3	893.5	30.9	1839
July	9.9	349.6	12.1	744
August	4.4	155.4	5.4	332
September	9.0	317.8	11.0	654
October	27.1	957.0	33.1	2035
November	27.0	953.5	32.9	1958
December	41.7	1472.6	50.9	3130
Mean	23.4	826.4	28.56	20,678

C830920 Mt Reksten DER 83-05-11

- provided by C. Beach
- requested our review
- asked to estimate the RP of 1929 annual?, lowest historic months and to estimate the annual runoff for a 20-yr RP
- asked us to estimate the 50-year peak inflow

COAST MOUNTAIN AQUASOURCE LTD.

Freil Lake Bulk Fresh Water Export Proposal
Colin A. Beach
Water Management Branch Files 2000058 and WA-16g

PROPOSED OPERATION OF THE FREIL LAKE RESERVOIR

BASED ON MEAN ANNUAL INFLOWS

DATA BASE: Lois River below Scanlon Dam, Station 08GB003

PERIOD OF RECORD: 1922-29, prior to construction of the dam.

MONTH	(1) AVAILABLE WATER FROM FREIL LAKE ACRE FEET INFLOW	(2) LESS RELEASE AT SEASONAL AVERAGE FLOW IN DAYLIGHT HOURS ONLY* (1) × Avg. daylight/24	(3) LESS RELEASE TO OYSTER LARVAE HABITAT**	(4) LESS MAX. RELEASE TO SHIP (BARGE) (1)-(2)	EQUALS VOLUME OF STORAGE REMAINING
JAN.	2447	890		1557	4940
FEB.	1966	831		1135	4940
MAR.	1494	741		753	4940
APR.	1595	913		682	4940
MAY. 1-15	1202	750		452	4940
MAY 16-31	1282	*	1282	314 ?	4626
JUN.	1839	*	1839	619	4007
JULY	744	*	744	619 ?	3388
AUG.	332	*	332	619	2769
SEP.	654	392 262		619	2412
OCT.	2035	914	357	619	2914
NOV.	1958	746		619	3507
DEC.	3130	1078		619	4940
TOTAL	20,678	7,205	4,197	9,226	

1333

* = Water to be released from behind the dam at the discharge from the lake, on a dawn to dusk basis; volume has been computed with reference to total hours of daylight projected by the Dominion Astrophysical Observatory, Vancouver, B.C. Note that during the period of May 16 to August 31, the flow for aesthetic reasons would be provided for by the flow for oysters.

** = discharge to ocean during the critical season in order to provide a fresh water lens for the regional oyster larvae habitat.

MONTH	TOTAL 1983 PROJECTED HOURS OF DAYLIGHT* (SUNRISE TO SUNSET)	NUMBER OF DAYS IN THE MONTH	AVERAGE NUMBER OF HOURS OF DAYLIGHT
January	270.73	31	8.73
February	284.15	28	10.15
March	369.09	31	11.91
April	412.16	30	13.74
May 1-15	224.67	15	14.98
May 16-31	250.59	16	15.66
June	485.12	30	16.17
July	488.74	31	15.77
August	445.39	31	14.37
September	378.24	30	12.61
October	334.30	31	10.78
November	274.57	30	9.15
December	256.42	31	8.27
Total	4,474.17	365	

* - based on information from the Dominion Astrophysical Observatory, 5071 West Saanich Road, R.R. # 5, Victoria, B.C., V8X 4M6; telephone: 388-3157

COAST MOUNTAIN AQUASOURCE LTD.

Freil Lake Bulk Fresh Water Export Proposal
Colin A. Beach
Water Management Branch Files 200058 and WA-16g

Data Base: Lois River below Scanlon Dam, Station 08GB003
Period of record: 1922 through 1929, prior to the construction of the dam.

Lois River drainage area = 456 km.^{2} = 112,691.28 acres

Freil Lake drainage area = 3,894 acres

Ratio of drainage areas = 0.03455

1 cubic metre = 35.315 cubic feet

For the period of complete record of 1922 - 1929, the year 1929 had the lowest mean flow at Lois River. The mean flow for the year 1929 was 15.4 cubic metres per second, while the mean annual flow for the 8 year period, 1922 - 1929, was 23.4375 cubic metres per second. Therefore, the flow in 1929 was only 65.7 per cent of the mean annual flow for the 8 year period. What follows is an extrapolation of the low flow year of 1929, for the Freil Lake drainage:

MONTH	LOIS RIVER - 1929 CUBIC METRES/SEC.	C.F.S. Lois River	C.F.S. Freil Lake	Acre Feet Freil Lake
January	14.7	519.13	17.94	1102.84
February	4.28	151.15	5.22	290.02
March	13.0	459.09	15.86	975.30
April	26.0	918.19	31.72	1887.68
May	35.4	1250.15	43.19	2655.82
June	28.7	1013.54	35.02	2083.70
July	10.5	370.81	12.81	787.74
August	5.16	182.23	6.30	387.12
September	2.70	95.35	3.29	196.03
October	12.7	448.50	15.49	952.79
November	6.63	234.14	8.10	481.36
December	24.4	861.69	29.77	1830.56
Mean	15.4	544	18.79	13,630

COAST MOUNTAIN AQUASOURCE LTD.

Freil Lake Bulk Fresh Water Export Proposal
Colin A. Beach
Water Management Branch Files 2000058 and WA-16g

DATA BASE: Lois River below Scanlon Dam; Station 08GB003

PERIOD OF RECORD: 1922 through 1929, prior to the construction of the dam.

Lois River drainage area = 456 km.^{2} = 112,691.28 acres

Freil Lake drainage area = 3,894 acres

Ratio of drainage areas = 0.03455

1 cubic metre = 35.315

SAMPLE OPERATION OF PROPOSED FREIL LAKE RESERVOIR BASED ON 1929, DRYEST YEAR OF THE 1922-1929 COMPLETE 8 YEAR RECORD AT LOIS RIVER BELOW SCANLON DAM, PRIOR TO THE CONSTRUCTION OF THE DAM:

MONTH	AVAILABLE WATER FROM FREIL LAKE ACRE FEET	LESS RELEASE AT SEASONAL AVERAGE FLOW (AESTHETICS)*	LESS RELEASE TO OYSTER LARVAE HABITAT **	LESS MAX. RELEASE TO SHIP (BARGE)	EQUALS VOLUME STORAGE REMAINING
JAN.	1103	401		702	4940
FEB.	290	123		488	4619
MAR.	975	484		488	4622
APR.	1888	1081		487	4940
MAY 1-15	1285	802		483	4940
MAY 16-31	1371		1371	264	4676
JUNE	2084		2084	264	4412
JULY	788		788	264	4148
AUG.	387		387	264	3884
SEP.	196	103		264	3713
OCT.	952	428		265	3972
NOV.	481	183		265	4005
DEC.	1830	630		265	4940
TOTAL	13,630	4,235	4,630	4,763	

* = dawn to dusk as per Dominion Astrophysical Observatory projection.

** = during critical season; covers requirement for aesthetics also.

COAST MOUNTAIN AQUASOURCE LTD.

Freil Lake Bulk Fresh Water Export Proposal
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Water Management Branch Files 2000058 and WA-16g

CALCULATION OF INFLOWS FOR FREIL LAKE BASED ON THE LOWEST FLOW MONTHS OF THE 8 YEAR PERIOD OF RECORD AT LOIS RIVER BELOW SCANLON DAM, 1922-1930, PRIOR TO THE CONSTRUCTION OF THE DAM.

MONTH	LOIS RIVER CUBIC METRES PER SECOND	LOIS R. C.F.S.	FREIL L. C.F.S.	FREIL LAKE ACRE FEET
January	11.3	399	13.8	849
February	4.28	151	5.2	289
March	11.8	417	14.4	885
April	13.9	491	17.0	1012
May	16.7	590	20.4	1254
June	11.8	417	14.4	857
July	3.46	122	4.2	258
August	1.67	59	2.0	123
September	2.34	83	2.9	173
October	4.06	143	4.9	301
November	6.63	234	8.1	482
December	23.8	840	29.0	1783
TOTAL				8,266

8,266 acre feet per annum = 22.646575 A.F./day = 986,484.8 C.F./day = 7,379,419.2 U.S. Gallons per day

Sep 18, 1983 P.I.K. a,

LOIS RIVER DRAINAGE AREA 456 km^2

456 km^2 × 247.13 = 112,691.28 ac

Frail Lake Drainage area = 3,894 ac

Ratio of drainage areas = $\frac{3,894}{112,691.28}$ = 0.03455

Use this ratio as to convert Lois River flows to flows in the creek flowing out of Frail Lake

Mean monthly flows in Lois River

	m^3/sec		CFS		Frail Lake CFS
Jan	32.6	× 35.315 =	1151.3	× 0.03455 =	39.8
Feb	29.0	× " =	1024.1	× " =	35.4
Mar	19.9	× " =	702.8	× " =	24.3
Apr	22.0	× " =	776.9	× " =	26.8
May	33.1	× " =	1,168.9	× " =	40.4
Jun	25.3	× " =	893.5	× " =	30.9
Jul	9.9	× " =	349.6	× " =	12.1
Aug	4.4	× " =	155.4	× " =	5.4
Sep	9.0	× " =	317.8	× " =	11.0
Oct	27.1	× " =	957.0	× " =	33.1
Nov	27.0	× " =	953.5	× " =	32.9
Dec	41.7	× " =	1,472.6	× " =	50.9
MEAN	23.4	× " =	826.371	× " =	28.51 "

FREIL LAKE

MONTHS	MEAN FLOW CFS	DAYS	TIME sec.	VOLUME CU. FT CFS × DAYS × SEC	ACCUMULATED VOLUME CUBIC FT
JAN	39.8	31	86,400	106,600,320	106,600,320
FEB	35.4	28	"	85,639,680	192,240,000
MAR	24.3	31	"	65,085,120	257,325,120
APR	26.8	30	"	69,465,600	326,790,720
MAY	40.4	31	"	108,207,360	434,998,080
JUN	30.9	30	"	80,092,800	515,090,880
JUL	12.1	31	"	32,408,640	547,499,520
AUG	5.4	31	"	14,463,360	561,962,880
SEP	11.0	30	"	28,512,000	590,474,880
OCT	33.1	31	"	88,655,040	679,129,920
NOV	32.9	30	"	85,276,800	764,406,720
DEC	50.9	31	"	136,330,560	900,737,280
MEAN	28.5511	365	"		900,387,490

DAY = $24^{h} \times 60^{m} \times 60^{s} = 86{,}400$ sec.

Mean annual flow $= \frac{900{,}737{,}280}{365 \times 86{,}400} = 28.56$ CFS

$\frac{900{,}737{,}280}{43{,}560} = 20{,}678$ Ac-ft.

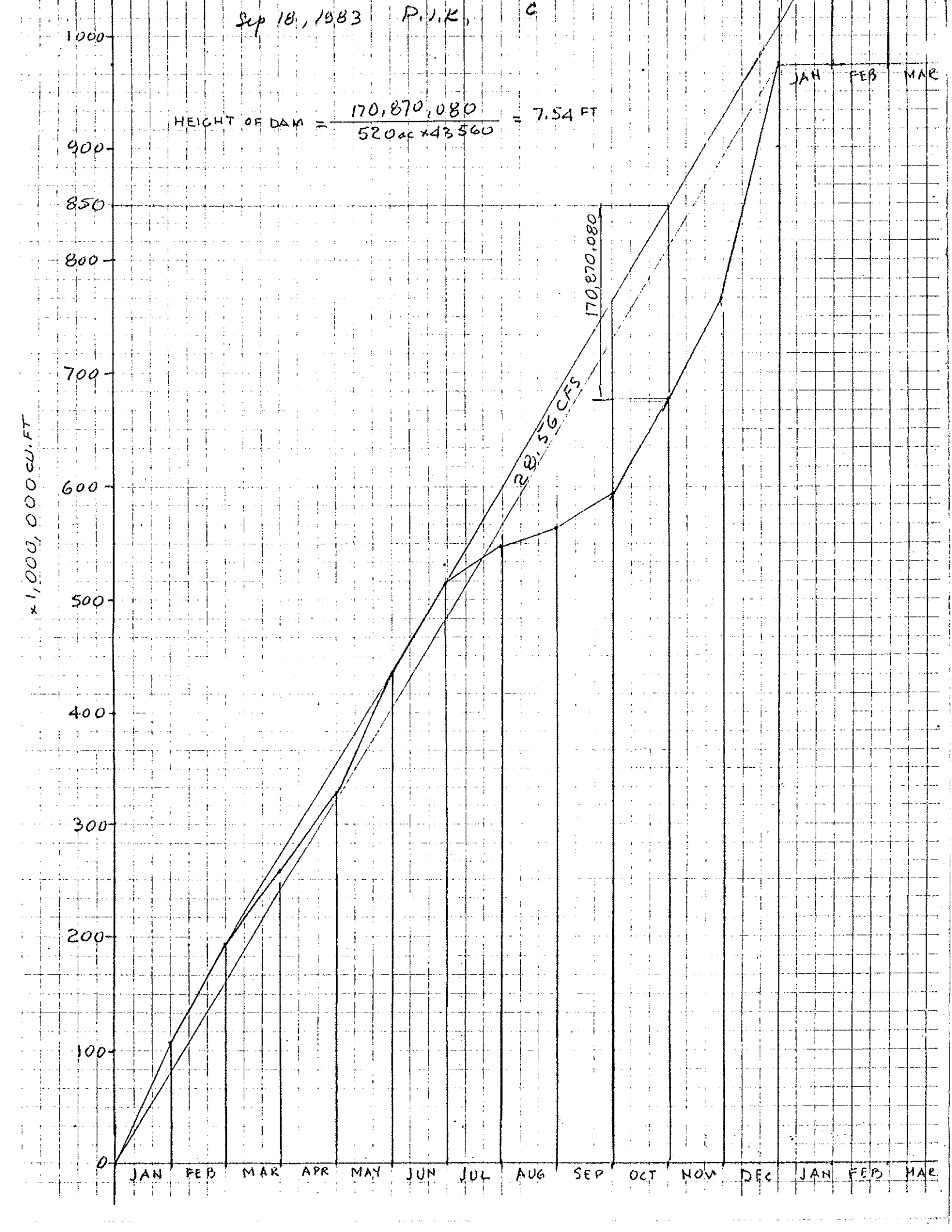
$\frac{20{,}678}{19{,}000} = 1.0883$ 8.83% > than 19,000 Ac-ft

$\frac{26.26}{28.56} = 0.919$ 8.05% smaller flow than flow extrapolated by ratio of areas.

Mean annual volume of 19,000 ac-ft should be from Frail Lake drainage assumed as as good approximation.

Sep 18, 1983 P.J.K.

$$\text{HEIGHT OF DAM} = \frac{170,870,080}{520\text{ac} \times 43560} = 7.54\text{ FT}$$



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: C.H. Coulson, Head
Surface Water Section
Water Management Branch

Date: Sept. 30, 1983

Re: Freil Lake, Coast Mountain
Aquasource Ltd.

As requested, Mr. Barr has reviewed the September 19, 1983 submission from Mr. Beach which incorporates items discussed at the meeting on September 14, 1983.

Lois River unit runoff data has been used to estimate Freil Lake runoff, resulting in a new mean annual runoff estimate of 20,678 acre-feet. Our suggestion was to use the original estimate of 19,011 acre-feet, and estimate monthly runoff using the monthly distribution for Lois Lake. The difference in monthly runoff estimates is not significant so no further revision is necessary.

The following estimates are provided for Mr. Beach:

1. The 1929 annual runoff has a drought frequency return period of 20 years.
2. The annual runoff synthesized from the minimum recorded runoff for each month for Lois River has a return period of 400-500 years.
3. The 50 year return period daily peak inflow is estimated at 15.1 m^3/s. (This estimate is derived from regional streamflow data and can be considered only a rough estimate).

A general comment on the supply-demand data provided in the submission is that based on the assumed operating procedure, a reservoir capacity of 4,940 acre-feet is more than what is required.

D.E. Reksten
Senior Hydrological Engineer
Surface Water Section
Water Management Branch
387-1111

L.J. Barr
Technician
Surface Water Section
Water Management Branch
387-1111

DER/dma

6831003

W-372

October 5, 1983

Mr. Colin A. Beach
Coast Mountain Aquasource Ltd.
1248 Keith Road
West Vancouver, B.C.
V7T 1M9

Dear Mr. Beach:

In reference to your analysis of the Freil Lake basin, dated September 19, 1983, please find enclosed a review of the submission and the estimates you requested for peak and low flows. Should you have any questions with regard to the accompanying memorandum pleaee contact the undersigned.

Yours truly,

C.H. Coulson, Head
Surface Water Section
Water Management Branch
387-1111

Encl.
cc: Mr. J.E. Farrell
Deputy Comptroller of Water Rights
Ministry of Environment
818 Fort Street
Victoria, B.C.
V8V 1X5