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September 11, 2003

Jacques Whitford Project No. BCV50304
LWBC File No. Z118466

Mr. Bob Herath, P.Eng.
Section Head - Land & Water Allocation
Land and Water BC Inc.
200-10428 153rd Street
Surrey, BC V3R 1E1 V

Dear Mr. Herath:

Re: Hotel Lake Water Supply Study, Pender Harbour, BC
Environmental Technical Response

This letter has been prepared in response to environmental concerns raised by community members with respect to the Sunshine Coast Regional District's proposed Water Licence on Hotel Lake. Based on Jacques Whitford's review the letters of concern submitted to Land and Water BC Inc. (LWBC) and issues raised at the public meeting held on August 29, 2003 at the Sunshine Coast Regional District offices, we understand the community concerns with the application to be:

- potential changes in water quantity/water level;
- potential changes in water quality; and
- potential effects on threespine stickleback, a 3-5 cm long fish, in Hotel Lake.

Each of these issues has been addressed below.

ESTIMATED WATER DEMAND AND EFFECTS ON WATER LEVEL

In our (Jacques Whitford's) report/application dated April 29, 2003, we cited average monthly water demands from Hugh G. Harris & Associates Inc.'s report entitled "Preliminary Report: Hydrology of Hotel Lake at Pender Harbour Area, Sunshine Coast, BC" dated May 30, 2002. The 2002 report estimated the peak water demand to be 5,344.4 m^3/month based on the estimated water demand for

Daniel Point Development Ltd. proposed residential development. Since the 2002 report was completed, the Sunshine Coast Regional District (SCRD) has submitted a Water Licence application to Land and Water BC Inc. to withdraw 5,304.4 m^3/month from Hotel Lake.

In the August 29 public meeting it was noted that some water licences issues to the Garden Bay Waterworks District had not been included in the 2002 HGH hydrology report and there was a request to confirm the total volume of water in the lake. To address these two issues, Jacques Whitford has revisited the lake bathymetry and volume calculations previously reported. The raw bathymetry data collected by Jacques Whitford in 2001 was reprocessed, a new bathymetry model was run, lake surface areas at depths of 0.0, -0.5 and –1.0 m were calculated, and lake volumes below the same depths were calculated.

In addition to the bathymetric modelling, a water balance for Hotel Lake was calculated based on:

- average precipitation, calculated using Environment Canada's 30-year climate normal data (see Drawing No. 1 attached);
- runoff statistics for Roberts Creek and Lang Creek;
- evaporation rates at the University of British Columbia (the closest station data available);
- total licenced water use from Hotel Lake; and
- demand from the proposed Water Licence.

This approach follows the general methodology used in Jacques Whitford's June 2003 submission to Fisheries and Oceans Canada and the data used in these calculations is appended to this letter. It should be noted that no data for exfiltration from the lake or groundwater contributions to the lake were available for inclusion in the water balance. However, these losses and gains will be consistent between the existing conditions and future conditions (if the Water Licence is granted) and therefore the intent of the water balance is to demonstrate the net change in water levels in light of the additional water consumption.

The water volume and surface areas are presented below.

Table 1. Hotel Lake Surface Area and Water Volume

Lake Depth (m)	Surface Area at Depth (m^2)	Volume Below Depth Contour (m^3)
0.0	275,884	1,665,058
-0.5	268,594	1,533,230
-1.0	260,916	1,399,164

As shown above, Hotel Lake contains 1.665 x 10^6 m^3 of water. With the exception of the lake volume below the –1.0 m depth contour, these calculations are all between 0.28% and 3.1% of the surface area/volume data previously reported. These data suggest that the 1.208 x 10^6 m^3 lake volume below the –1.0 m depth contour reported in the 2002 HGH report was a typographical error and should have read 1.408 x 10^6 m^3.

Land and Water BC Inc.'s web site shows thirteen existing Water Licences on Hotel Lake with a total volume of 541 m^3/day or 16,455.4 m^3/month. The proposed SCRD Water Licence is for an additional 174.37 m^3/day or 5,303.8 m^3/month; this will result in a 32.3% increase in licenced water withdrawals to 21,760 m^3/month. This data shows that the annual sum of all Water Licences for Hotel Lake, including the current SCRD application (261,110 m^3/year), is roughly equivalent to the volume of water in the top 1.0 m of the lake.

Drawing No. 2, attached, provides a graphical summary of the water balance. The monthly water balance summary is presented in Table 2 below and shows the net discharge from Hotel Lake after considering all water inputs and losses. A positive number indicates the total outflow from the lake via the creek channel at Acadian Road and a negative number indicates lake drawdown. A detailed breakdown of the water balance is attached to this letter. This water balance indicates that, for an average year, inflow to the lake exceeds water losses for all but two months per year. Drawdown of the lake water level below 51.1 m above sea level occurs between late June and early September, with recharge of the lake starting in mid September. Over the course of a year, the annual water volume that discharges from the lake via the outlet creek will decrease by 9.3% from 684,486 m^3 to 629,830 m^3.

Table 2. Hotel Lake Monthly Water Balance Summary

Month	Existing Conditions	Conditions With New Water Licence
January	131,300.81	125,894.41
February	106,763.99	101,880.79
March	81,420.59	76,014.19
April	33,965.08	28,733.08
May	18,014.27	12,607.87
June	677.07	-4,554.93
July	-26,797.51	-32,203.91
August	-23,321.41	-28,553.41
September	1,213.35	-4,193.05
October	65,165.56	59,759.16
November	146,705.64	141,473.64
December	149,378.89	143,972.49
Total	**684,486.32**	**620,830.32**

The effect of the water inflow and outflow/withdrawal on the lake water level though the summer months is shown on Drawing No. 3, attached. This shows that there is currently a maximum cumulative draw down of 190 mm occurring in August and September with recharge occurring in late October. With the new Water Licence, the maximum cumulative drawdown would be 260 mm in September with complete recharge of the lake by early November. The increased water consumption would result in a net increased drawdown of 70 mm. As noted above, the water balance does not take into consideration exfiltration from the lake or groundwater contributions to the lake; however, this information will not affect the difference in maximum drawdown as it will be consistent between the two scenarios. It is also worthy to note that this has been calculated based on average precipitation data and does not reflect conditions during a dry year.

As a component of the Water Licence application, a 200 mm high concrete weir has been proposed at the outlet of the lake. This weir will increase the outlet elevation from 51.1 m to 51.3 m above sea level providing an additional ±55,175 m^3 of water storage in the lake and hold the high water level at the current winter water levels for an extended period. This additional storage capacity is approximately twice the additional water demand for the June through October period when drawdown and recharge occur thus ensuring that any increase in summer water consumption does not adversely affect water levels in the lake.

POTENTIAL CHANGES IN WATER QUALITY

The second point of concern raised was the potential effect of the increased water demand on water quality in the lake. Of specific concern were:

- the potential for the additional drawdown to "pull" groundwater contaminated by the septic fields servicing homes around the lake into the lake; and
- reduced flushing of septic field contamination entering the lake.

The potential effects of the SCRD Water Licence on the summer low water levels in Hotel Lake have been discussed above. With the installation of the weir at the lake outlet, the summer low water level will not be altered and therefore there a "pull" of groundwater into the lake is not anticipated. Assuming the property owners around the lake have designed, constructed, and are maintaining their septic tanks and fields in accordance with current best practices, the septic fields should continue to operate in a manner that prevents sewage contamination of the lake. The proposed Water Licence will not lower the summer groundwater table and therefore will not affect the operation of the waterfront properties' septic fields.

Base on the bathymetric model and water balance, the water in Hotel Lake has an average residence time of ±18.5 months. Total water inputs to the lake are 1.072 x 10^6 m^3 while the total lake volume is 1.665 x 10^6 m^3. The SCRD's Water Licence application will not alter the inflow or total volume of the lake; it only alters the route by which the water leaves the lake. As a result of the new Water Licence, 620,830 m^3/year of water will flow out of the lake via the creek at Acadian Road and 63,656 m^3/year will flow out via the SCRD water supply infrastructure rather than the current 684,486 m^3/year of water flowing via the creek at Acadian Road. The total inflow and outflow will not be altered and therefore the current level of flushing will not be altered.

THREESPINE STICKLEBACK

The threespine stickleback is a common fish in both marine and freshwater environments along North America's Pacific coast from California through Alaska and form an important diet item for gamefish (*e.g.*, trout) and aquatic birds (*e.g.*, American merganser and heron). Threespine sticklebacks are typical inhabitants of shallow bays, lakes and slow flow streams and are often found in association with aquatic vegetation. Threespine sticklebacks are slow swimmers (skullers) and tend to be benthic feeders. Their food consists primarily of plankton (*i.e.*, copepods and ostracods), aquatic insect larvae, small crustaceans and algae. A detailed study of the threespine stickleback in Little Campbell River[1], determined that while hybrids between the marine and freshwater forms are common, they are extremely rare outside of a narrow hybrid zone, and that the two forms should be treated as distinct species.

Freshwater populations in northern BC and Alaska reach sexual maturity in their first or second year and live a maximum of three years. Breeding occurs during summer (April – September). The male constructs a saucer shaped nest with bits of detritus, algae/aquatic plants, sticks and/or sand cemented together with a mucilaginous, kidney secretion, usually in shallow water and in association with aquatic plants. Males are highly territorial and will mate with several females and husband up to six hundred eggs during a single season. After fertilizing the eggs, the male emerges from the nest, attacks the female and drives her off. Hatching occurs in about seven days at 18°C. When the young are completely free swimming, they remain in a dense school around the male for a short time and eventually disperse.

Stickleback populations in lakes can be either allopatric or sympatric. An allopatric population is one where all of the fish in the lake form a single reproductive group and the differences between various stickleback populations in a region is due to geographical isolation. A sympatric pair occurs when two distinct populations evolve in a lake but do not interbreed due to some reproductive isolating mechanism (rather than geographic isolation); for sympatric stickleback pairs, one group consists of a limnetic

[1] Hagen 1967. cited in McPhail, J. D. and C. C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173. 381 pp.

(open-water feeding) population and the other is a benthic (bottom feeding) population. The two populations are capable of interbreeding and producing fertile offspring but do not under "normal" environmental conditions.

At present, there is concern and considerable evolutionary fisheries biology research being conducted (University of British Columbia) regarding the existence of and potential for extinction of sympatric stickleback pairs in coastal BC lakes[2]. Sympatric stickleback pairs in four study lakes on Texada Island are either extinct (Hadley Lake) or endangered (Enos, Paxton and Vananda lakes; Committee on the Status of Endangered Wildlife in Canada; COSEWIC) due to the interbreeding of the two populations. The study attributes the extinction of the Hadley Lake pairs and primary threat to the remaining three pairs to the introduction of exotic species, and upland development (both urban and forestry related) /or forest harvesting practices that promote bank erosion and increase turbidity in the lake.

With regards to exotic species, the study describes the extinction of both sympatric and allopatric populations of stickleback brought about through the introduction of predatory brown catfish and sunfish into Hadley and other BC lakes. Like trout and other gamefish, the stickleback formed a component of the catfish and sunfish food source; however, in this case the predation was to a level that eliminated entire populations.

Increased turbidity, the second major threat to the sympatric stickleback population pairs is attributable primarily to land development. With the loss of riparian vegetation buffer adjacent of creeks or around lakes during clearing or logging activities, there is often an increase in erosion which deposits sediments into streams/lakes and leads to a resultant increase in the turbidity of the receiving waters. The reduced water clarity facilitates hybridization between the limnetic and benthic populations which is thought to induce the collapse or transformation of the original populations into a single hybrid population. The specific mechanisms by which turbidity leads to hybridization are currently unclear, but appear to be related to a disruption of visual signals during mating. Slight difference in male spawning coloration allows the females to distinguish between the males of other sympatric population. With increased turbidity, the female's ability to distinguish between males is diminished, thus increasing the likelihood of hybridization.

The proposed increase of licenced water withdrawals from Hotel Lake (from 16,455.4 m^3/month to 21,760 m^3/month) by the SCRD application and subsequent mitigation plans to increase the storage capacity of the lake will not adversely affect threespine stickleback population(s) in Hotel Lake. The applied for Water Licence will not introduce exotic fish species to Hotel Lake. Nor does it require any upland works that may increase the potential for erosion or sedimentation of the lake. As the project

[2] P. M. Wood. 2003. Will Canadian policies protect British Columbia's endangered pairs of sympatric sticklebacks? In: *Fisheries* vol. 28 no. 5, May 2003. pp 19-26.

does not propose any removal of riparian vegetation (the Daniel Point development property is actually in another watershed), there will be no related increase in lake turbidity due to construction activities.

The concrete weir and proposed habitat compensation works have been targeted toward mitigating potential environmental effects of the increased water withdrawal on trout and chub populations in Hotel Lake. As trout are typically more susceptible to environmental changes than other fishes, these measures will mitigate potential effects on threespine stickleback and other fish species in the lake as well. Installation of the proposed concrete weir has been proposed to increase the storage capacity of Hotel Lake and therefore ensure the currently low water level at maximum draw down is not reduced any further. As a result, loss of shallow littoral habitats will not occur nor is an increase in lake turbidity due to wave action stirring up sediments in shallow areas of the lake projected to occur. As well, construction of the proposed mitigative works (*i.e.*, the concrete weir at lake outlet, realignment of the outlet creek channel *etc.*) will be implemented during the in-stream work window established by Fisheries and Oceans Canada (August 01 – September 15). At this time, the lake water level will be below the discharge elevation and therefore will be completed in complete isolation of flowing water. Installation of silt fencing and re-vegetation of all riparian disturbances will further protect fish habitats during and post-construction. The low water timing of the project will eliminate/minimize any sedimentation/turbidity increase and thus reduce the potential for hybridization of littoral and benthic stickleback pairs. As indicated above, threespine stickleback require shallow, slow flow stream or still-water environments, preferably in association with instream vegetation. Therefore, maintaining the lake high water level at 51.3 m above sea level will increase overall lake surface area throughout much of the year, including the summer low flow stickleback spawning period and therefore may increase the available spawning area for stickleback.

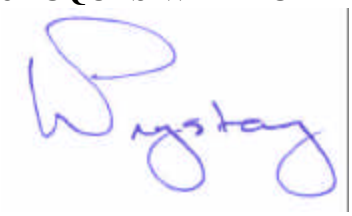
In summary, the applied-for Water Licence, commensurate with implementation of proposed increased storage capacity, fish migration weir, silt fencing, development of lake outlet trout habitat, riparian re-vegetation and low water level construction timing, should have no net impact on threespine stickleback populations in Hotel Lake.

CLOSURE

We trust that the information provided in this letter addresses the concerns of the local community residents and Land and Water BC Inc. If you have any questions about the content of this letter or need any further information, please contact the undersigned by telephone (604-436-3014) or e-mail (wprystay@jacqueswhitford.com).

Yours truly,

JACQUES WHITFORD ENVIRONMENT LIMITED

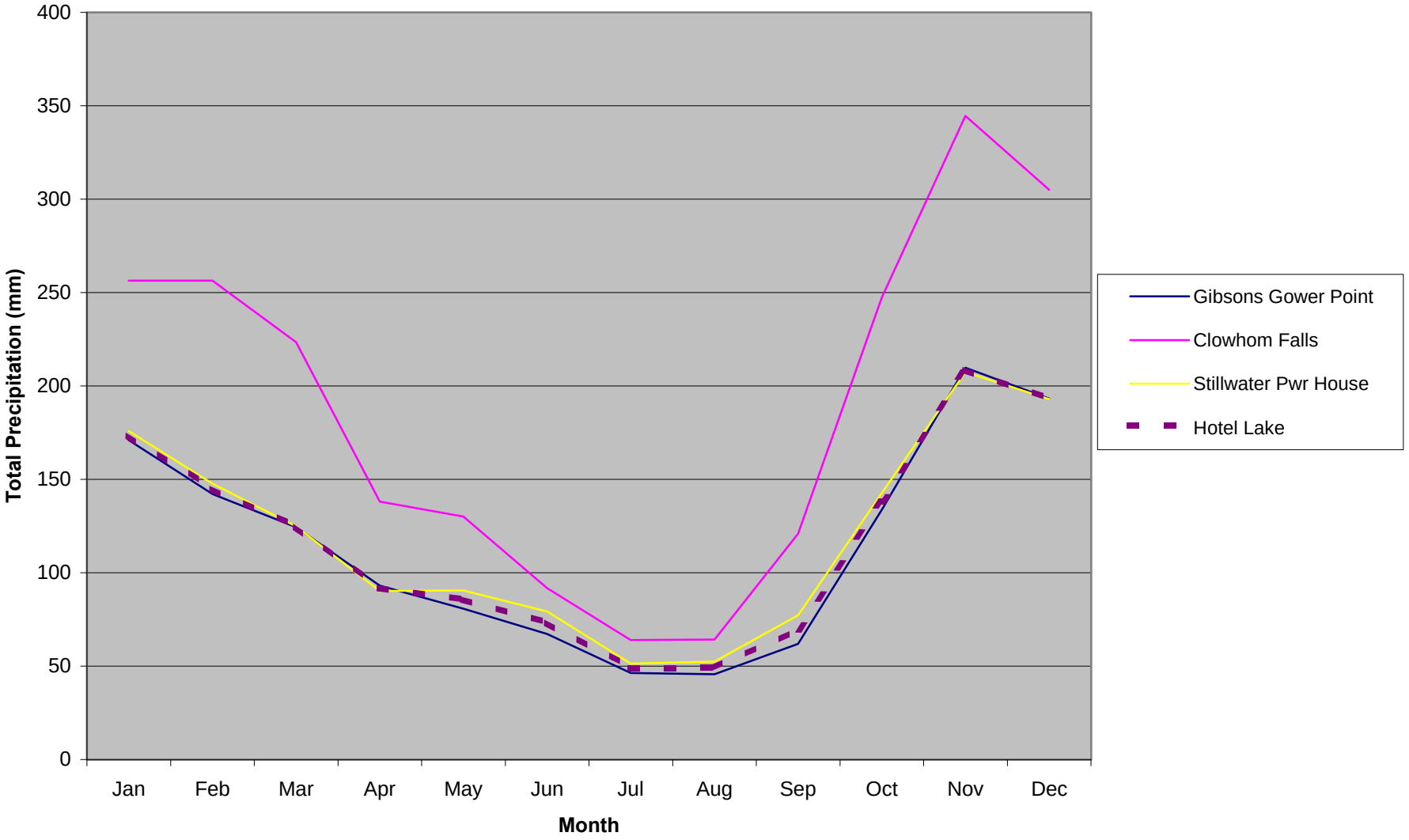


Ward Prystay, M.Sc., R.P.Bio.
Division Manager, Environmental Sciences

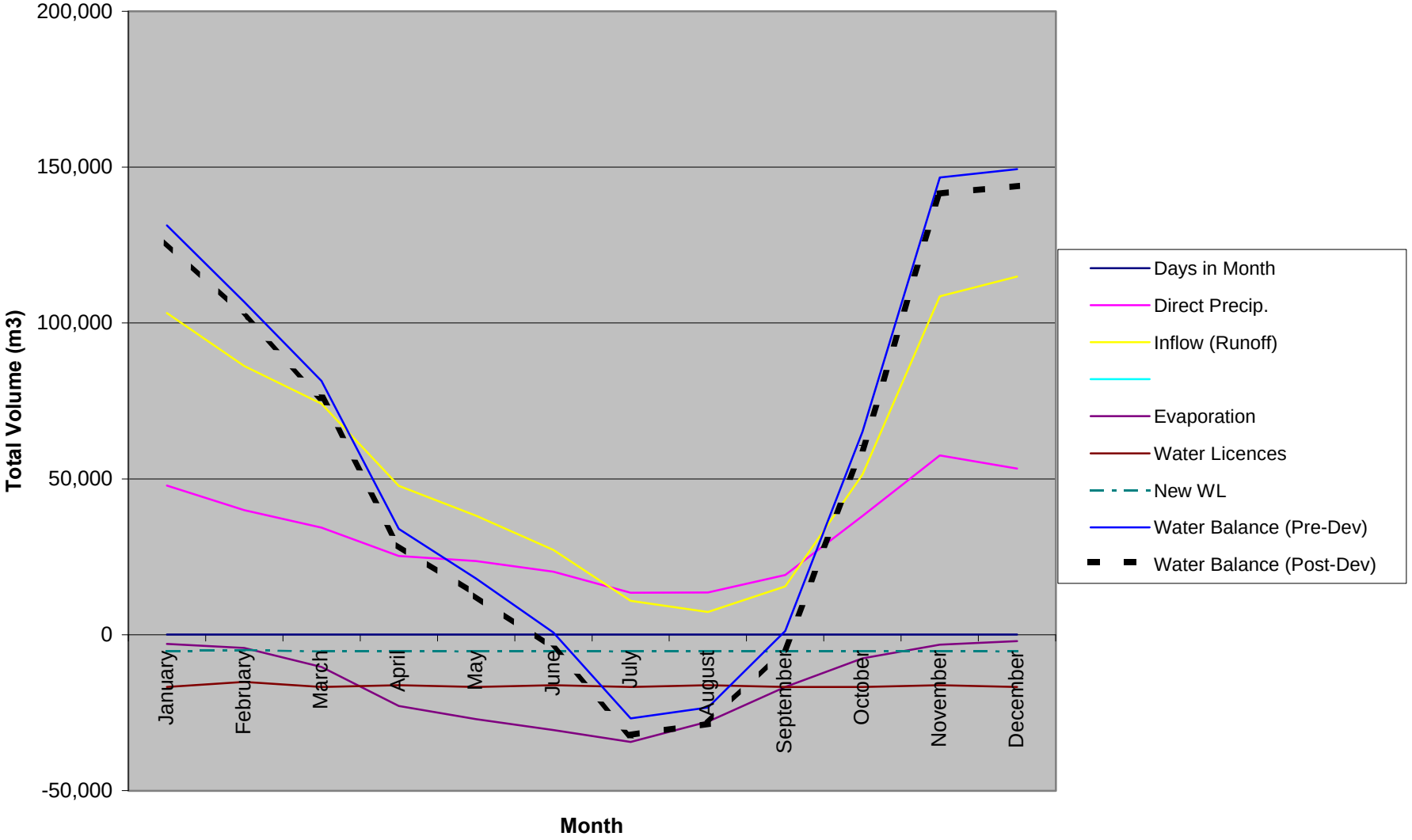
Attachments: Drawings No. 1, 2 and 3
Hotel Lake Water Balance
Monthly Runoff Ration Calculations
30-year Climate Normals
Water Licence Summary Table

cc. Dave Nanson, DFO
Rob Knight, MWLAP
Hugh Harris, Hugh G. Harris & Associates Ltd.
Les Allen, Daniel Point Projects Ltd.
Steve Lee, Sunshine Coast Regional District

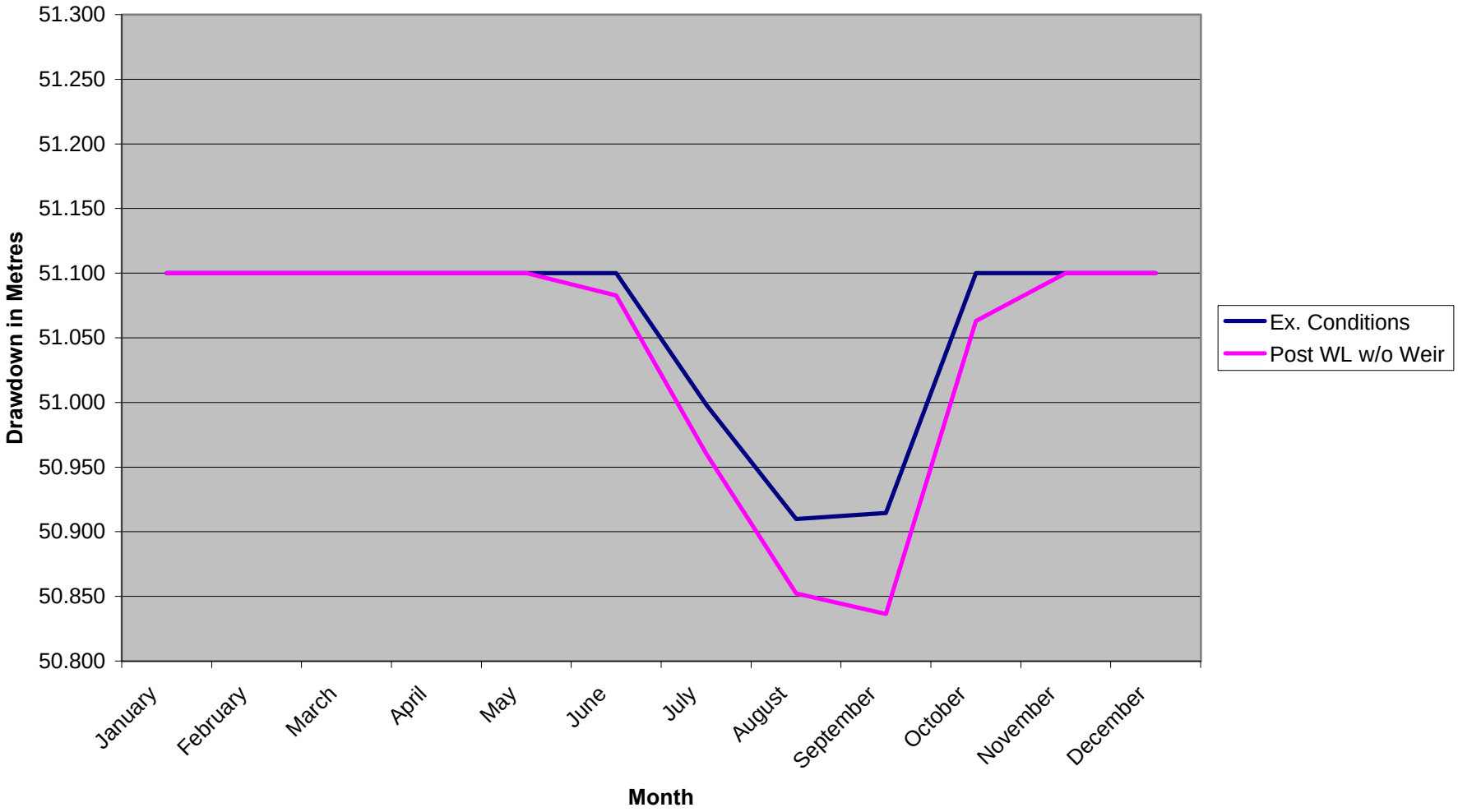
Hotel Lake Water Supply Study - Environmental Technical Response
Drawing No. 1: Sunshine Coast 30-Year Climate Normals - Precipitation



Hotel Lake Water Supply Study - Environmental Technical Response
Drawing No. 2: Typical Year Water Balance



Hotel Lake Water Supply Study - Environmental Technical Response
Drawing 3. Water Level Based on Cummulative Drawdown
for a Typical Year w/o Concrete Weir



Hotel Lake Water Balance - Average Year

					Water Demand (m3)		Water Balance (m3)[5]	
Month	**Days in Month**	**Direct Precip. (m3)[1]**	**Upland Runoff (m3)[2]**	**Evaporation (m3)[3]**	**All Ex. WLs[4]**	**SCRD/DPD WL**	**Existing**	**With New WL**
January	31.00	47,852.08	103,199.28	-2,979.55	-16,771.00	-5,406.40	131,300.81	125,894.41
February	28.00	39,975.59	86,212.60	-4,276.20	-15,148.00	-4,883.20	106,763.99	101,880.79
March	31.00	34,375.15	74,134.51	-10,318.06	-16,771.00	-5,406.40	81,420.59	76,014.19
April	30.00	25,298.56	47,739.71	-22,843.20	-16,230.00	-5,232.00	33,965.08	28,733.08
May	31.00	23,629.46	38,220.03	-27,064.22	-16,771.00	-5,406.40	18,014.27	12,607.87
June	30.00	20,208.50	27,238.93	-30,540.36	-16,230.00	-5,232.00	677.07	-4,554.93
July	31.00	13,476.93	10,899.29	-34,402.73	-16,771.00	-5,406.40	-26,797.51	-32,203.91
August	30.00	13,532.11	7,295.94	-27,919.46	-16,230.00	-5,232.00	-23,321.41	-28,553.41
September	31.00	19,201.53	15,528.98	-16,746.16	-16,771.00	-5,406.40	1,213.35	-4,193.05
October	31.00	38,140.96	51,409.99	-7,614.40	-16,771.00	-5,406.40	65,165.56	59,759.16
November	30.00	57,535.61	108,572.69	-3,172.67	-16,230.00	-5,232.00	146,705.64	141,473.64
December	31.00	53,273.20	114,890.64	-2,013.95	-16,771.00	-5,406.40	149,378.89	143,972.49
TOTALS	**365.00**	**386,499.69**	**685,342.59**	**-189,890.96**	**-197,465.00**	**-63,656.00**	**684,486.32**	**620,830.32**

Notes:
1. Calculated by multiplying montly precipitation by lake surface area
2. Calculated by multiplying monthly precipitation by upland watershed area by runoff ratio
3. Calculated by multiplying avgerage monthly evaporation (UBC) by surface area of lake

30-Year Climate Normals[1] (mm of precipitation per month)

Month	Gibsons Gower Point	Stillwater Pwr House	Clowhom Falls	Hotel Lake
Jan	171	175.9	256.4	173.5
Feb	142.1	147.7	256.4	144.9
Mar	124.4	124.8	223.5	124.6
Apr	93.1	90.3	138.1	91.7
May	80.8	90.5	130.1	85.7
Jun	67.2	79.3	91.8	73.3
Jul	46.4	51.3	63.9	48.9
Aug	45.6	52.5	64.2	49.1
Sep	61.9	77.3	120.9	69.6
Oct	133.8	142.7	247.4	138.3
Nov	209.7	207.4	344.6	208.6
Dec	193.2	193	305	193.1
Total	**1369.2**	**1432.7**	**2242.3**	**1401.0**

Note:
1. Obtained from www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html
2. Hotel Lake precipitation calculated by averaging data from Gibsons Gower Point & Stillwater Pwr House
3. Clowhom Falls data not utilized

Monthly Runoff Ratio Calculations Based on Roberts Cr. & Lang Cr.[1]

Date	Precipitation (mm)	Averaged Runoff Statistics for Roberts Cr. & Lang Cr.[2] (mm/d)	Days in Month	Monthly Discharge Calc: (mm/month)	Runoff Ratio (Disch./Precip.)	Runoff Ratio: Corrected
January	173.45	4.6	31.0	143.4	0.8	0.8
February	144.90	4.6	28.0	127.5	0.9	0.8
March	124.60	3.9	31.0	122.0	1.0	0.8
April	91.70	3.3	30.0	97.8	1.1	0.7
May	85.65	2.6	31.0	79.1	0.9	0.6
June	73.25	1.2	30.0	36.2	0.5	0.5
July	48.85	0.7	31.0	21.8	0.4	0.3
August	49.05	0.4	30.0	12.1	0.2	0.2
September	69.60	0.6	31.0	19.8	0.3	0.3
October	138.25	2.1	31.0	65.4	0.5	0.5
November	208.55	4.6	30.0	139.4	0.7	0.7
December	193.10	5.4	31.0	166.3	0.9	0.8

Notes:
1. The runoff ratio reflects the proportion of the total preciption to upland areas that will reach a creek or lake
2. Raw data obtained from http://scitech.pyr.ec.gc.ca/climhydro/mainContent/main_e.asp?province=bc

Hotel Lake Water Licences - Summary Table

Licence No	Purpose	Quantity	Units	**Quantity in m3/d**	Licensee	Licence Status	Priority Date	Issue Date
C016733	Domestic	500	GD	2.27	SUNSHINE COAST SCHOOL DISTRICT NO 46 BOX 220 GIBSONS B C V0N1V0	Current	19450728	0
C017526	Waterworks Local Auth	7300000	GY	90.92	GARDEN BAY WATERWORKS DISTRICT ATTN: SANDY LOXTERKAMP BOX 21 GARI	Current	19460315	0
C024211	Domestic	4000	GD	18.18	NELSON PETER J 11670-218 ST MAPLE RIDGE V2X5M1	Current	19580206	0
C030375	Domestic	2000	GD	9.09	387987 BC LTD 2345 MATHESON BLVD EAST MISSISSAUGA ON L4W5B3	Current	19321024	0
C037713	Domestic	500	GD	2.27	UHRLE KARL 481 VENTURA CRESCENT NORTH VANCOUVER BC V7N3G8	Current	19701118	0
C037714	Domestic	500	GD	2.27	HAWRYCHUK FRANK & CARON BOX 7 GARDEN BAY BC V0N1S0	Current	19701217	0
C039324	Domestic	500	GD	2.27	CROFT SHARON L & BRIAN J 21237 43 AVE LANGLEY BC V3A7R9	Current	19711014	0
C045086	Domestic	500	GD	2.27	JAMES RALPH B 12011 MITCHELL RD RICHMOND BC V6V1M7	Current	19750225	0
C048529	Waterworks Local Auth	10950000	GY	136.38	SUNSHINE COAST REGIONAL DISTRICT PO BOX 800 SECHELT BC V0N3A0	Current	19690423	0
C062623	Waterworks Local Auth	4015000	GY	50.01	GARDEN BAY WATERWORKS DISTRICT ATTN: SANDY LOXTERKAMP BOX 21 GARI	Current	19720324	0
C072130	Irrigation	6	AF	190.95	TRI LAKES DEVELOPMENT LTD PO BOX 37 GARDEN BAY BC V0N1S0	Current	19650323	0
C113624	Nurseries	1	AF	31.82	KNIGHT RONALD LEONARD & CARLA 2710 WALPOLE CRESCENT N. VANCOUVER I	Current	19980915	19990430
C113624	Domestic	500	GD	2.27	KNIGHT RONALD LEONARD & CARLA 2710 WALPOLE CRESCENT N. VANCOUVER	Current	19980915	19990430
	Total Existing Demand (m3/day)			**541.00**				
Z118466	Waterworks Local Auth	14000000	GY	174.37	SUNSHINE COAST REGIONAL DISTRICT PO BOX 800 SECHELT BC V0N3A0	Active Appl.	20030515	0

Total Demand with New WL Application (m3/day)	**715.37**
Total Demand with New WL Application (m3/year)	**261,109.94**

Note: Accessed from http://www.elp.gov.bc.ca:8000/pls/wtrwhse/water_licences.input on 7 September 2003