HYDROLOGY SECTION REPORT

Cowichan River
Surface/Groundwater Study

The Hydrology Section has completed a study of the discharge measurements carried out by the Surveys Section between August 26 and October 7, 1986. There were measurements taken on six dates at each of three sections identified in Figure 1. The objective of the study was to determine if there was a measureable change in flow in the Cowichan River past the City of Duncan water supply well field.

The measurements were made during the low flow period so that small changes in flow between sections could be identified. Groundwater Section data indicate that the well field pump rate was steady and continuous at or near 15,000 USgpm (approximately 1 cubic metre per second) during the tests. The river discharge was measured using standard metering procedures and compared with coincident data from the WSC (Water Survey of Canada) station (#08HA011) at Allenby Bridge which is about 0.2 km downstream from section (1).

The collected data are summarized in Table 1. These data were subjected to an elementary stage rating analysis from which it was concluded that the data were within $\pm$5% of actual. This level of accuracy is corroborated by preliminary WSC data shown in Table 1.

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TABLE 1

Cowichan River
Observed Discharge Measurements (cms)

Date	Section (1)	Allenby Bridge WSC Gauge** Concurrent-Sec(1)	Section (2)	Section (3)
Aug. 26	3.78	3.67	3.23	3.07
Sep. 9	4.01(3.95)*	3.76	3.41	3.28
Sep. 16	4.65(4.45)*	4.43	3.89	4.08(3.60)
Sep. 23	8.00	7.8	6.96	7.11
Sep. 30	8.05(7.45)*	7.6	6.42	6.41
Oct. 7	5.39	5.14	4.61	4.76

( )*Correction for surge wave from Crofton Mill diversion
**WSC data is preliminary

Note: Allenby Bridge, Section (2) and (3) are 0.2, 2.4 and 3.5 km downstream of Section (1) respectively

Cowichan River flow is regulated by the control structure located at the outlet of Cowichan Lake. While flow is diverted at many sites between this control and Section (1), only the Crofton Pulp and Paper Division of B.C. Forest Products diversion of 2.25 cms is large enough to warrant

monitoring. This diversion is about 1.0 km upstream of Section (1). Our metering program was coordinated where possible, with the mill operations to minimize the affect of unsteady flow. Unsteady flow resulted when pumping was periodically reduced by 25% (approximately 0.6 cms) causing a corresponding surge in the river. Where the pump related surge interference could not be avoided, the following adjustments (noted in Table 1), were made to compensate the measurements:

August 26:	No adjustment
September 9:	Reduce Q_1[(1)] by 10% of 0.6 cms
September 16:	Reduce Q_1 by 33%; Q_3 by 80% of 0.6 cms
September 23:	No adjustment
September 30:	Reduce Q_1 by 100% of 0.6 cms
October 7:	No adjustment

The correction was based on the travel time of the surge to the metering section using shallow water wave celerity ($c = \sqrt{gd}$; where g = gravitational constant and d is the estimated river depth).

Observed flow changes from Section (1) to (2) and (3) are listed in Table 2, using the adjusted values of discharge.

(1) Q_1, Q_2 and Q_3 are the respective discharges at Section (1), Section (2) and Section (3)

TABLE 2

Cowichan River Flow Reductions

Discharge Reference	Discharge and Depletion (cms)					
	Aug. 26	Sept. 9	Sept. 16	Sept. 23	Sept. 30	Oct. 7
Discharge						
Cowichan Lk*	7.1	7.1	7.1	9.9	9.9	7.1
Q_1	3.78	3.95	4.45	8.00	7.45	5.39
Depletion						
$Q_1 - Q_2$	.55	.54	.56	1.04	1.03	.78
$Q_1 - Q_3$	.71	.67	.85	.89	1.04	.63
$Q_2 - Q_3$	.16	.13	.29	-.15	0	-.15

*Cowichan Lake outflow is approximate and for reference only

From above to below the well field area, which is considered to be $Q_1 - Q_3$, there is an apparent mean loss of 0.8 cms, (.63 to 1.04). This amounts to about 80% of the indicated pumping rate from groundwater during the observation period.

Accuracy of hydrometric measurements is expected to be within ±5% whereas the measured loss of 0.8 mps is about 15% of the flow at Section (1). It can be concluded that the loss is a real loss and not the result of measurement error.

It may also be observed that the measured river loss is somewhat less than the pumping rate, and that at least part of the flow to the wells is supplied from other sources.

R.P. Richards, P. Eng.
Head, Operations
Hydrology Section
Water Management Branch
387-9480

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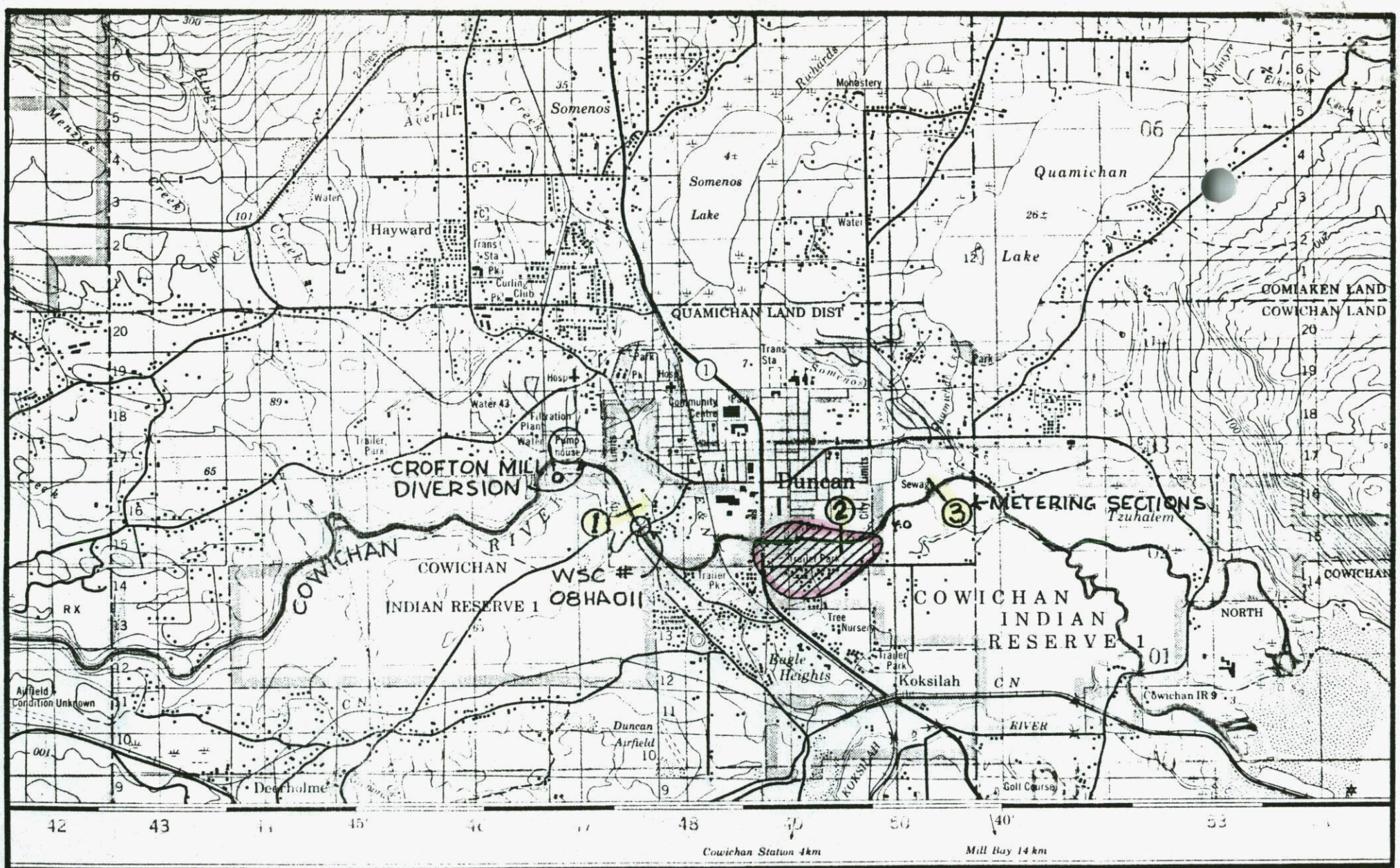

Cowichan River
Surface Water - Groundwater Study

SITE PLAN WITH
RIVER METERING SECTIONS

Nov. 1986 R.P. Richards Figure 1