BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

Harford, Kennedy, Wakefield Ltd. - Hat Creek Project - Detailed Environmental Studies - Noise - Environmental Impact Report - August 1978

ENVIRONMENTAL IMPACT STATEMENT REFERENCE NUMBER: 53

BRITISH COLUMBIA HYDRO

AND

POWER AUTHORITY

HAT CREEK PROJECT

DETAILED ENVIRONMENTAL STUDIES

APPENDIX E1 - NOISE

ENVIRONMENTAL IMPACT REPORT

AUGUST, 1978.

BY

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File No. 82-161-1

August 11, 1978.

Mr. J.C. Edwards, Coordinator
Detailed Environmental Studies
Hat Creek Project
B.C. Hydro & Power Authority
Generation Planning Department
24th Floor, Harbour Centre,
555 W. Hastings Street,
Vancouver, B.C.

Dear Mr. Edwards :

Re : Detailed Environmental Studies, Hat Creek Project,
Appendix E 1 - Noise

We enclose herewith for your consideration the final version of our Environmental Impact Report on Noise from the proposed Hat Creek Project, thus fulfilling the terms of reference for Appendix E 1 - Noise, of the Detailed Environmental Studies, June, 1977.

Respectfully submitted,

HARFORD, KENNEDY, WAKEFIELD LTD.

C.W. Wakefield

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PREFACE

In conjunction with the preparation of a Conceptual Design Study for the Hat Creek Thermal Generating Facility by a joint venture of Intercontinental Engineering Ltd., Vancouver and Ebasco Services of Canada, Toronto, the British Columbia Hydro and Power Authority has commissioned a number of detailed environmental impact studies of the project. The detailed environmental studies have been coordinated by Ebasco Services Canada Ltd., Environmental Consultants; formerly Envirosphere Company.

Harford, Kennedy, Wakefield Ltd. (formerly Aero Acoustic Systems Ltd.) was selected to carry out that portion of the environmental studies relating to the impact of project noise (Appendix E1-Noise).

Credit for the map of the Hat Creek Valley duplicated on the cover of this report goes to B.C. research, Dolmage Campbell & Associates.

S U M M A R Y

The existing acoustic environment of the Hat Creek Project Study Area (see Figure 1) was established through a series of 24-hour continuous noise measurements at five locations: four in the Hat Creek Valley around the mine site and one at the proposed site of Make-up cooling water supply system intake near Ashcroft. Except near Highway 12 and to a much lesser extent, the Hat Creek Road, the existing noise levels in the valley are those of the natural environment; that is, having day-night average noise levels of 30 to 40 dBA* depending on weather conditions and nearness to trees and water bodies. At the Ashcroft water intake site, the noise levels are more typical of an urban residential area due to the train traffic on the nearby Canadian Pacific and Canadian National Railway mainlines.

Using a variety of published sources, empirical models and field measurement data, the total sound power levels to be created by the construction and operation phases of the mine [Open Pit no. 1 to maximum 183 m (600 ft.) depth], plant (four 500 MW generating units) and offsite facilities were predicted. It has not been possible, in general, to predict noise levels for the project decommissioning activities because of a lack of detailed information regarding them. However, qualitative comparisons have been made with the noise levels from project construction and operation. In general, construction and operating equipment lists and descriptions have been obtained from the appropriate project engineers. When specific information about equipment noise levels or operating parameters was lacking or insufficient or when a range of possible conditions existed, a conservative stance (i.e. leading to higher noise levels) was taken. These sound power levels were then converted to yearly day-night average noise levels (YDNL)* at the

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* See the Glossary for definitions of decibels (dB), dBA, day-night average noise level and other acoustical terminology.

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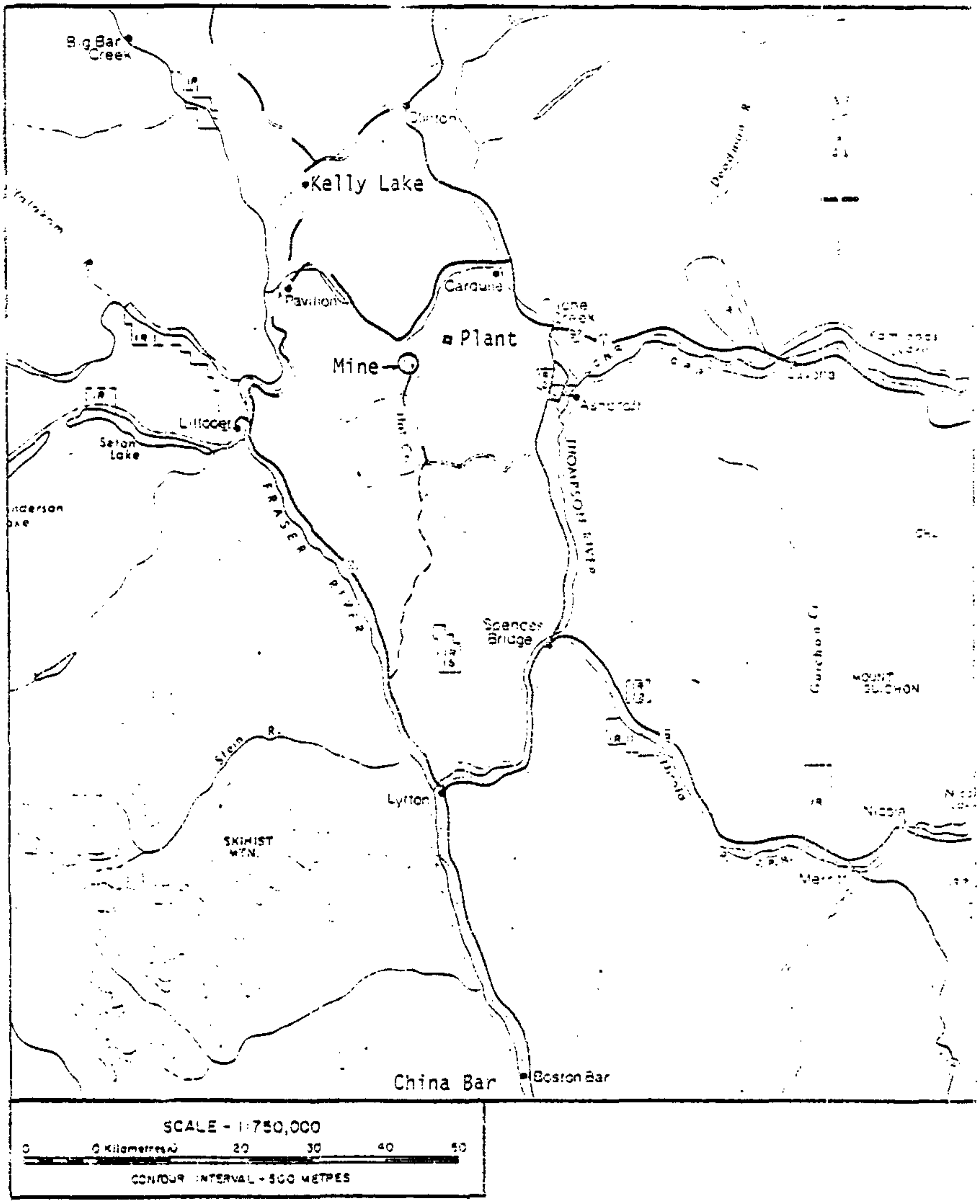

FIGURE 1: STUDY AREA SHOWING NEIGHBOURING TOWNS

various noise receptor locations throughout the study area, using a conservative sound propagation model. This was done for the first (peak construction) and worst (full operation) years of the project.

Predicted project noise levels were combined with the without-project noise levels (both existing and probable future) to obtain the noise environment which will exist if the project proceeds. The impacts of the predicted increases in environmental noise levels on residential areas, cattle grazing and agricultural lands and recreational areas were evaluated. The criteria used to assess noise impact in residential areas (the major concern here) were largely those proposed by the United States Environmental Protection Agency in March 1975 (Reference No. 79). These noise level criteria are designed to protect people from severe health effects (hearing loss and others), and from deterioration of the public health and welfare due primarily to noise interference with activities such as speech communication and sleep, both with an adequate margin of safety. A third type of noise impact is identified which relates to the probable severity of negative public reaction to intruding noise. The first two criteria take the form of fixed threshold levels of noise below which no impact is assumed and above which negative effects on health and welfare increase steadily. The third, an impact scale, attempts to account for the very personalized sensitivity of individuals or communities to intruding noise. This impact scale takes into account such factors as the existing environmental noise level, previous exposure to the intruding noise, nature and duration of the intruding noise and community attitudes towards the noise producer. These and other noise criteria used in this study are listed in Table 1.

From the above criteria, two scales of residential area noise impact significance were developed which are sensitive to the increase in environmental noise levels due to the project as well

	JURISDICTION OF NOISE LEVEL CRITERION	NOISE LEVEL CRITERION	COMMENTS	REFERENCE
1.	Severe Health Effects in Humans	$L_{eq}(24)$ 70	To protect against hearing loss and various stress-related diseases over a working lifetime.	U.S. EPA Levels Document (Ref. 79)
2.	Residential Land-Use Incompatibility	YDNL 55	To protect against negative effects on public health and welfare: interference with activities, e.g. speech communication and sleep.	U.S. EPA Levels Document (Ref. 79)
3.	Annoyance and Public Reaction Thresholds	YDNL of Intruding noise 10 dB below existing YDNL, or normalized YDNL of Intruding Noise 5 dB below Existing YDNL.	No public reaction if meet either criterion. If don't, public reaction increases with normalized YDNL.	U.S. EPA Levels Document (Ref. 79)
4.	Grazing Land-Use Incompatibility	YDNL 65	To provide suitable environment for stock raising.	U.S. F.A.A. Airport Noise Evaluation Procedure (Ref. 82)
5.	Agricultural Land-Use Incompatibility	$L_{eq}(24)$ 70	As in 1.	U.S. EPA Levels Document (Ref. 79)
6.	Unpopulated Areas (Recreation)	Natural Sound Levels (YDNL 30 to 40)	No single criterion available, but any identifiable noise intrusion considered envi[illegible]mental degradation	U.S. EPA Levels Document (Ref. 79)
7.	[illegible]ry Infrequent Intermittent Noises (Nighttime) 5 to 30 sec. duration	With-Project YDNL [illegible]s 20 dBA to maximum of 75 dBA	Outdoor, A-weighted [illegible]vel; Threshold of significant sleep disturbance	Vancouver International Airport Noise [illegible]udy (Ref. 85)

TABLE 1: SUMMARY OF NOISE LEVEL CRITERIA

	JURISDICTION OF NOISE LEVEL CRITERION	NOISE LEVEL CRITERION	COMMENTS	REFERENCE
8.	Public Address and Signal Systems (Frequent use)	Essentual Inaudibility above background noise of continuous project activities	Outdoors at nearest residence , present or future (See Section 5.2 e)	
9.	Impulsive noise (Blasting and Circuit Breakers)	140 dB peak Linear	Outdoors at project property Line or nearest unprotected receptor on site.	Worker's Compensation Board of British Columbia January 1, 1978 Regulations.

TABLE 1: SUMMARY OF NOISE LEVEL CRITERIA (Cont'd.)

as to the ultimate with-project noise level. These scales were then used to rank the project noise impacts in five categories: Insignificant, Low, Moderate, High and Extreme.

During the initial construction phase (1978-1979) there were nine noise impact situations identified in residential areas, three involving only one or two Hat Creek Valley ranch houses (see Figure 2). Of these impacts, the significance of two were judged to be very low (Insignificant) three to be Low and four to be Moderate. Two moderate construction noise impacts were identified at the small residential area (6-7 homes) at the confluence of the Thompson and Bonaparte Rivers. These will result from construction of the make-up cooling water supply system intake and booster pumping station No. 1. The other moderate impacts will be on Bonaparte Indian Reserve 1, which has approximately 30 residents, and at the Ed Lehman ranch house. A summary of the predicted noise impacts is given in Table 2. The impacts of Table 2 are those which would arise from the project as currently planned, that is, with no extra noise control measures taken and using the worst case (noisiest) equipment when a selection is available.

During peak plant and mine operation years (Mining Stage 6), seven noise impact situations were identified for residential areas with three consisting of two ranch homes each. Table 2 again summarizes these impacts. The extreme impact was predicted for the two nearest Hat Creek Valley ranch houses to the south rim of the mine pit. These houses may be physically displaced by creek diversion facilities. The High impact was predicted for the Thompson-Bonaparte community upon assuming that no pumping station ventilation fan noise control would be done. The Bonaparte Indian Reserve 1 will suffer Moderate noise impact, primarily from mine operation, as will two presently occupied ranch houses in the Hat Creek Valley.

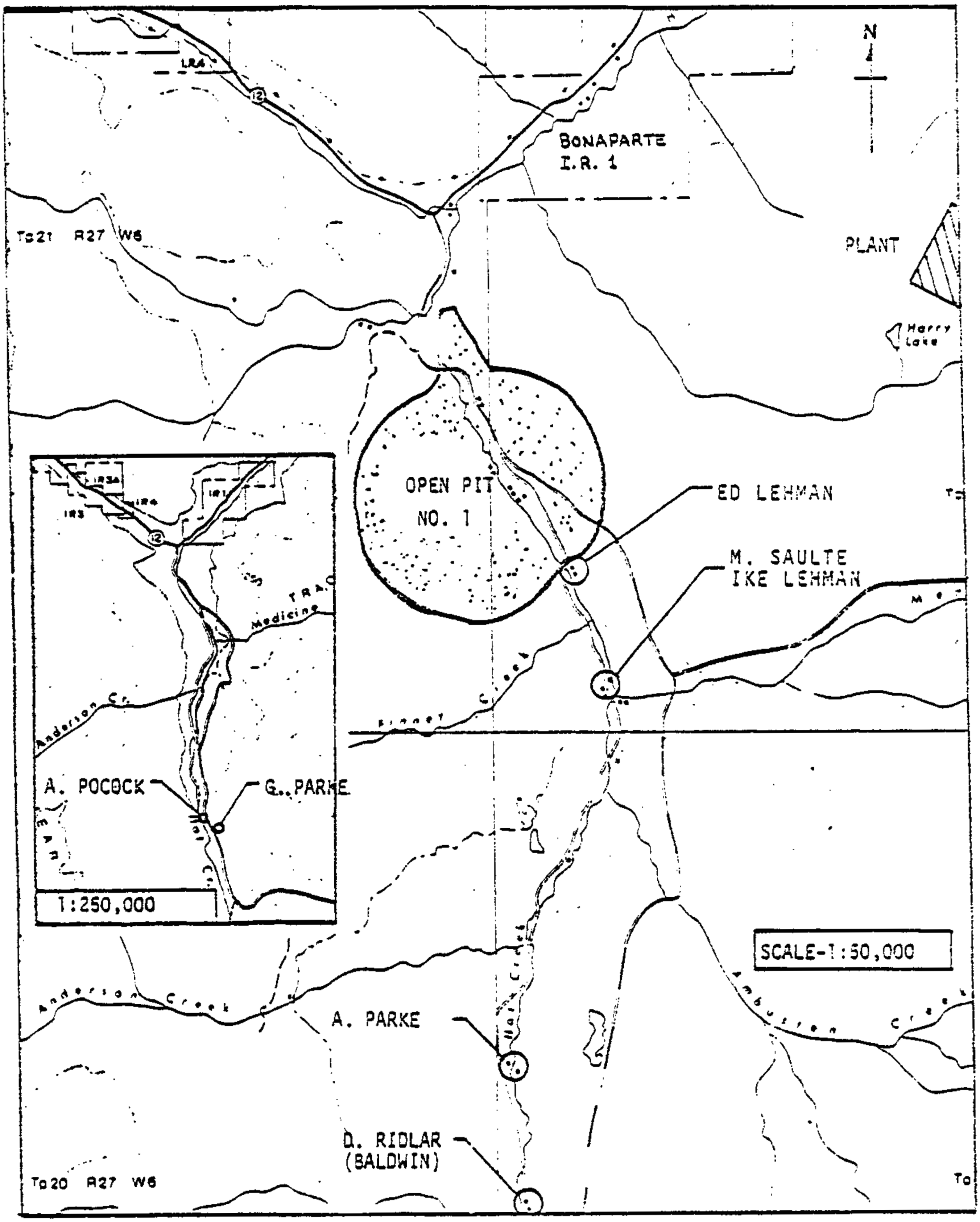

FIGURE 2: OCCUPIED UPPER HAT CREEK VALLEY RANCH HOUSES AS OF MARCH 1978

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RESIDENTIAL LOCATION		DOMINANT PROJECT NOISE SOURCE		IMPACT SIGNIFICANCE	
		FIRST YEAR OF CONSTRUCTION	PEAK OPERATION MINE STAGE 6	FIRST YEAR OF CONSTRUCTION	PEAK OPERATION (MINE STAGE 6)
Bonaparte Indian Reserve 1		North Valley Dump-Filling	Mine, coal Preparation and Plant Operation	Moderate	Moderate
UPPER HAT CREEK VALLEY RANCHES	E. Lehman	North Valley Dump-Filling	Home displaced	Moderate	--
	M. Saulte & I. Lehman	North Valley Dump-Filling	Mine Operation	Low	Extreme
	A. Parke & D. Ridlar	Plant Construction	Mine Operation	Insignificant	Moderate
	A. Pocock & G. Parke	Largely Inaudible	Mine and Plant Operation	--	Insignificant
Thompson- Bonaparte River Confluence Near Ashcroft		River Bottom Preparation	No Noise	Insignificant	--
		Water Intake Construction	Insignificant Noise Source	Moderate	--
		Pumping Station Construction	Pumping Station Operation	Moderate	High
North-Ashcroft Subdivision		Water Pipeline Construction	Equipment Off-loading and Trucking	Low	Low
Semlin Valley Near Airstrip Site C		Airstrip Construction	Airstrip Operation	Low	Low

TABLE 2: SUMMARY OF PROJECT NOISE IMPACT SIGNIFICANCE AT RESIDENTIAL LOCATIONS.

Significant non-residential noise impact will be restricted essentially to one grazing land-use incompatibility involving approximately a 600 m (2000 ft.) annulus around the mine pit for a total alienated grazing area of 3.9 $km.^2$ (1.5 square miles) during Mining Stage 6, and two recreation area degradations. These latter will be at the McClean Lake Indian Reserve (access road traffic noise) and in the Clear Range (hiking and riding area), which will be exposed to mining noise. Although there is no established noise criterion for such areas, it is felt that these two impacts will be in the low to moderate range.

It is believed that whenever an opportunity for inexpensive noise control presents itself, it should be taken. However, definite efforts should be made to reduce all project noise levels which will result in moderate, high or extreme noise impacts.

Mitigative measures for construction projects and mine operation centre on the initial selection of mobile equipment with documented low exterior noise levels, the regular replacement of deteriorating exhaust mufflers and the restriction of construction to daytime hours.

Because of its location, the power plant will produce much less residential area noise impact than will the mine. However, the selection of relatively quiet forced-draft, primary-air and induced-draft fans (the least quiet fans for which data was available were assumed herein) and the assurance of adequate plant wall construction will reduce occupational noise exposure within the plant boundaries and substantially reduce the amount of land rendered incompatible with cattle grazing throughout the Trachyte Hills to the east of the plant.

Sources of high level intermittent noise at the plant (steam line blowouts and electromatic valves), although they will not create significant impact in the Hat Creek Valley, do present the possibilities of instantaneous hearing damage to plant workers and of severe startle effects, with possible subsequent accidental injury, to both plant workers and to cattle and wild game in the plant vicinity. Plant workers should be protected from those hazards through the silencing of these steam vents and/or the manditory wearing of hearing protection. Only vent silencing can diminish the startle effect on animals.

The public address and signal systems serving the mine and coal preparation areas should be designed to minimize the spread of their noise beyond the boundaries of the project and attain essential inaudibility above the steady noise of the mining operation.

Circuit breakers at the plant should, through initial selection or exhaust silencing, be made compatible with the impulse noise criterion (see Table 1) at the nearest permitted approach distance.

Table 3 summarizes the effects of the recommended noise mitigation measures on the significance of noise impact at various receptor locations.

NOISE SOURCE	MITIGATIVE ACTION	SOURCE NOISE REDUCTION (dB) *	RECEPTOR LOCATION	OVERALL IMPACT SIGNIFICANCE		COMMENTS
				WITHOUT MITIGATION	WITH MITIGATION	
Induced-Draft Fans (Plant)	Fan Selection and/or Silencing	15+	Bonaparte Indian Reserve 1 (North end only)	Low	Insig.	Benefits only areas where plant noise dominates. Reduction of pure tone makes noise less annoying.
Forced-Draft and Primary-Air Fans (Plant)	Fan Selection and/or Silencing	12+	Trachyte Hills east of plant (Grazing)	Low	Insig.	Area where YDNL exceeds 65 is reduced to essentially within the plant boundaries.
Steam Line Blowouts (Plant)	Silencers	25(A)	Plant yard and Grazing land to east of plant	---	---	Plant workers protected against hearing damage and cattle and wildlife startle effects largely reduced.
Electromatic Valves (Plant)	Silencers and/or Hearing Protection for Workers	25(A)	Plant yard and Grazing land to east of plant.	---	---	Plant workers protected against hearing damage and startle reduced. Cattle and wildlife startle reduced with silencing.
Mine Construction Transformers	Barrier on North Side	10+	Bonaparte Reserve 1 (Southern boundary)	Insig. - Low	Insig. -	Without barrier, pure tone noise would be audible at night. With barrier, it would be inaudible.
Booster Pumping Station 1 Fans and Transformer	Ventilation fan selection and/or silencing. Transformer barrier	Fans:25(A) Transformer 10(A)	Residential Area at confluence of Bonaparte and Thompson Rivers.	High	Insig.	Fan and transformer noise would still be audible during quiet periods (e.g. between train events, low winds) but impact will be insignificant.

* Noise reductions refer either to the A-weighted sound level (A), or to the level in the controlling octave band at the receptor location.

TABLE 3 : EFFECT OF NOISE SOURCE MITIGATIVE ACTIONS ON NOISE IMPACT SIGNIFICANCE.

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1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

The detailed terms of reference for Appendix El - Noise, are delineated in the Proposed Hat Creek Development Detailed Environmental Studies Terms of Reference as prepared by B.C. Hydro, dated August 1977. In general terms, the noise impact study was to encompass:

1. the establishment, through field measurement, of the existing noise environment throughout the study area.
2. prediction of future noise environment with the project.
3. prediction of future noise environment without the project.
4. evaluation of noise impacts based on differences in future with and without-project noise levels and, where possible, the provision of a basis upon which the costs of these impacts can be evaluated.
5. the recommendation of measures to mitigate and compensate for noise impacts.

1.2 STUDY SCOPE

The scope of the noise impact study has encompassed all aspects of the mine, plant and offsite facilities with the exception of the 500 KV transmission line which is being dealt with in a separate study. The limits of the project scale as addressed herein are the development of Open Pit No. 1 to a depth of 183 m (600 ft.) and the construction of four 500 MW generating units.

The impact of noise from the bulk sample program has not been addressed in detail herein since separate reports were submitted to B.C. Hydro regarding the predicted and measured noise levels from the operation (see Acoustical Engineering Reports 72-161-12 "Preliminary Noise Impact Assessment of Hat Creek Bulk Sample Program" May 20, 1977, and 72-161-12a "Noise Levels Generated by the Hat Creek Bulk Sample Program, Trench A" June 8, 1977). However, the bulk sample program and other noise-producing pre-construction activities are discussed briefly.

The prediction of project noise impacts has been limited to impacts on the environment. That is, the question of occupational noise exposure for workers involved in the construction and operation of the project, has not generally been addressed. Comment has been made, however, on the exposure of plant construction and operation staff to high-level intermittent noise.

1.3 STUDY PERSONNEL

The professional personnel that have been involved in the noise impact study are as follows:

PERSONNEL	PROJECT ACTIVITIES
K. D. Harford, P. Eng.	- project administration, impact assessment, mitigation and compensation, baseline noise measurement.
C. W. Wakefield, M.A.Sc., P. Eng.	- project administration, prediction of noise levels and impacts, bulk sample study, report preparation.
D. S. Kennedy, P. Eng.	- noise source documentation, baseline noise measurement, report preparation.
S. H. Woodard, P. Eng. (Alta.)	- noise source identification.
C. D. Cairns, B.A.Sc.	- baseline noise monitoring and baseline noise data processing.

1.4 ACKNOWLEDGEMENTS

The authors are indebted to the staffs of the following facilities which permitted and assisted in the acquiring of noise level data on operating equipment:

1. Pacific Power and Light, Centralia, Washington,
2. Kaiser Resources,
3. Westshore Terminals Ltd., Robert's Bank,
4. Island Copper (Utah Mines).

2.0 RESOURCE INVENTORY METHODOLOGY

Resource inventory methodology is described in detail in Harford, Kennedy, Wakefield Ltd. Report 82-161-2 entitled "Baseline Noise Monitoring - Hat Creek Study". (See Appendix A). A more concise presentation is contained below.

Ambient noise levels were monitored throughout the Hat Creek Valley in October 1976. These measurements were then repeated in February and March 1977 to determine whether or not noise levels change as a result of seasonal differences in ground cover or general level of activity. In May 1977, an additional measurement was conducted near the site of the proposed pumping station in Ashcroft.

The purpose of all of the "baseline" noise measurements was to provide information necessary to evaluate future noise impact. Furthermore, the data obtained will provide a reference in the future should community noise problems ever develop.

2.1 NOISE DESCRIPTORS EMPLOYED

The L_{eq} or equivalent sound level is the level of a steady A-weighted sound which would result in the same total sound energy over a specified period of time as does the actual time-varying sound level over that time. The $L_{eq}(24)$ is the equivalent sound level over a 24-hour period.

The L_{dn} or day-night average sound level is similar to the $L_{eq}(24)$ except that a nighttime weighting factor of 10 dB is applied to noise levels generated between 10:00 p.m. and 7:00 a.m. in order to reflect the greater annoyance caused by noises during this period. This noise descriptor has been selected by the U.S. Environmental Protection Agency as being the community noise index which best relates to public health and welfare concerns, such as speech interference and annoyance.

Both the L_{eq} and the L_{dn} employ the average energy concept and hence varying noise levels are averaged logarithmically. This results in the peak noise levels receiving more emphasis than they would if the levels were averaged arithmetically. For this reason, the L_{eq} and L_{dn} are quite sensitive to high level intrusive noises even though they may be of short duration.

In addition to L_{eq} and L_{dn}, the monitoring equipment provided information on the statistical variation of noise levels throughout the measurement period. Various indices, L_i, were obtained representing the noise levels which were exceeded i% of the time. For example, the L_{10} is the level exceeded 10% of the time.

2.2 NOISE MONITORING EQUIPMENT

The basic noise monitoring system used for the baseline measurements consisted of a Bruel & Kjaer Precision Sound Level Meter Type 2204 and Octave Band Filter Set Type 1613, a General Radio Community Noise Analyser Model 1945, a Uher tape recorder Model 4400, and a Bruel & Kjaer Calibrator Type 4230. All of the equipment was battery operated and, with the exception of the microphone and an anemometer, was contained in a mobile laboratory.

2.3 NOISE MONITORING PROCEDURES

Continuous measurements were taken at all monitoring sites to determine the day-night average sound level, L_{dn}, and the various statistical indices. These measurements were made using the fast response (125 ms. time constant) setting of the noise analyzer in order to capture peak events like car passbys. Throughout these 24-hour periods, the most predominant noise events were automatically tape recorded so that the most significant noise sources at each site could be identified and so that any invalid data would be detected.

In addition to the continuous monitoring, periodic measurements were made of the background noise level in the nine octave bands. These periodic background measurements were taken using "slow" response (1 s. time constant) of the sound level meter.

During the fall at noise monitoring Sites 1 to 4, meteorological measurements were taken periodically by the technician who manned the noise monitoring lab. During the winter monitoring at these same sites, the lab was unmanned for the majority of the time and meteorological data was obtained from B. C. Hydro weather stations which were located in close proximity to the noise monitoring locations. In addition, wind speed data was automatically recorded on tape whenever noise levels at the lab exceeded a preset value. This was to ensure that microphone wind noise resulting from high wind speeds (> 12 m.p.h.) had not significantly influenced the results. At noise monitoring Site 5 (in Ashcroft), wind speed was again recorded on tape during high level noise events. However, since this monitoring was done on an unmanned basis, other meteorological data had to be obtained from the government weather observer stationed in Ashcroft.

During the fall monitoring at Sites 1 to 4, traffic counts were taken by the technician. In the winter, traffic counts were extracted from the tape recordings. At Site 5, no motor vehicle noise appeared on the tape recordings indicating that road traffic noise was insignificant relative to other sources, in particular, train traffic. Estimates of the volume of train traffic were obtained from Canadian National and Canadian Pacific railways.

2.4 MONITORING SITES

Four sites were chosen throughout the valley in an attempt to obtain readings indicative of the existing noise environment. Site 1 was chosen to be indicative of properties near Highway 12, west of the Hat Creek junction. Site 2 was essentially at the Hat Creek junction, and will be considered as indicative of properties near to Highway 12 east of the junction. Site 3 was chosen to be indicative of the properties near the Hat Creek Road, but away from the influence of Highway 12. Site 4 was selected as a sample of those areas which are well removed from any of the frequently travelled roads and, therefore, indicative of the essentially pristine parts of the valley. The locations of the four sites in the Hat Creek Valley are shown in Figure 2-1.

A monitoring site at Ashcroft (Site 5) was chosen to be indicative of the area in close proximity to the proposed pumping station. Figure 2-2 illustrates the exact location of this site.

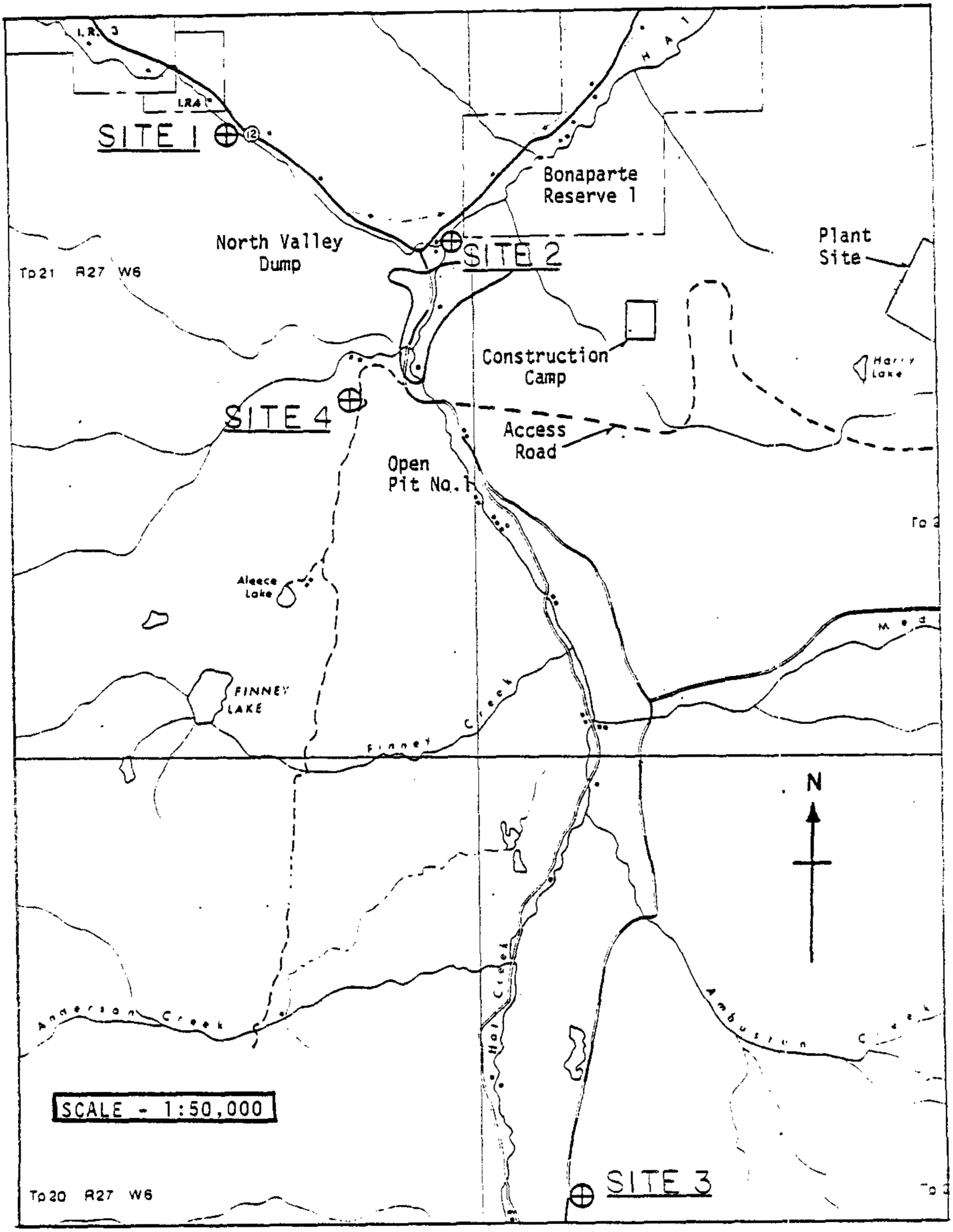

FIGURE 2 - 1 BASELINE NOISE MONITORING SITES IN THE HAT CREEK VALLEY

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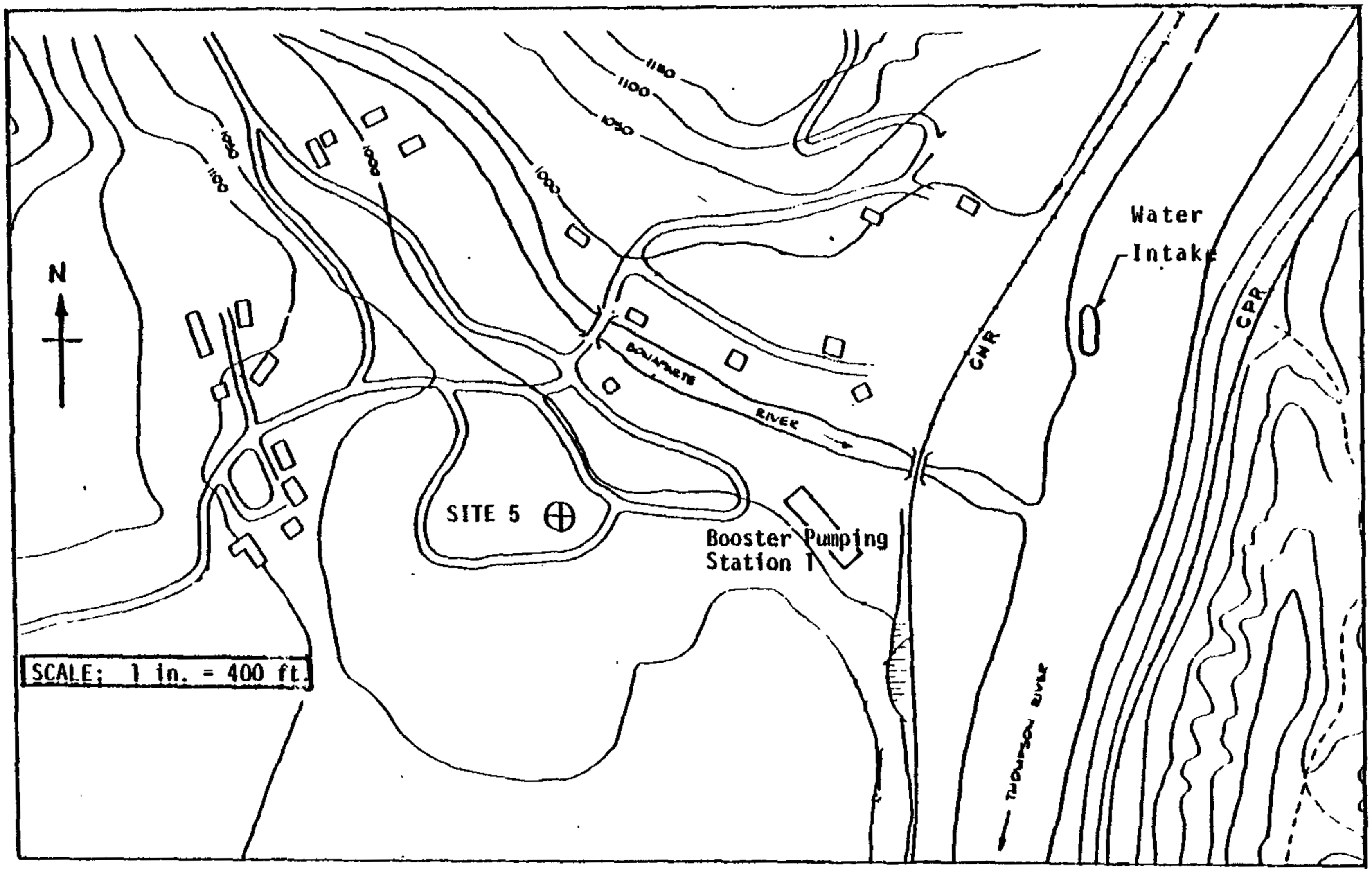

FIGURE 2-2: BASELINE NOISE MONITORING SITE 5 NEAR MAKE-UP COOLING WATER SUPPLY INTAKE AT ASHCROFT.

2.5 MONITORING SCHEDULE

At each of the Valley sites, two periods of 24-hour measurements were made during both the fall and winter monitoring programs; one on a weekday, and one on a weekend. Due to time lost in moving from one site to another, and in calibrating the system, some of the monitoring periods consisted of slightly less than 24 hours. At Site 5, only one 24-hour measurement was made, that being on a weekday in May 1977.

During the weekday winter monitoring at Site 1 on March 9, 1977, the microphone failed during the evening. Therefore, the night-time data was rejected and some redundant data obtained previously for a weeknight at this site was used in its place.

On March 5, 1977, unmanned monitoring was conducted at Site 4 to obtain data for a winter weekend. On this particular day, it was unusually windy resulting in high peak noise levels. During occasional calm periods, however, the background noise level was extremely low. As a result, the dynamic range of the measurement system was insufficient and the instrumentation was overloaded during wind gusts. Hence, the data obtained was invalid. However, since this site was remote from man-made sound, the data obtained for a weekday is also indicative of a weekend at this location. Repeat measurements were, therefore, not made. Table 2-1 presents the exact periods monitored.

SITE	FROM	TO	DESCRIPTION
1	2:00 a.m. Oct. 26/76	12 Midnight Oct. 26/76	Fall-Weekday
	12 Midnight Oct. 22/76	12 Midnight Oct. 23/76	Fall-Weekend
	7:00 a.m. March 9/77 11:00 p.m. Feb. 10/77	7:00 p.m. March 9/77 7:00 a.m. Feb. 11/77	Winter-Weekday
	8:40 a.m. Feb. 20/77	5:40 a.m. Feb. 21/77	Winter-Weekend
2	12 Midnight Oct. 24/76	12 Midnight Oct. 25/76	Fall-Weekday
	2:00 a.m. Oct. 24/76	12 Midnight Oct. 24/76	Fall Weekend
	8:00 a.m. Feb. 14/77	6:00 a.m. Feb. 15/77	Winter-Weekday
	8:00 a.m. March 6/77	6:00 a.m. March 7/77	Winter-Weekend
3	12 Midnight Oct 28/76	12 Midnight Oct. 29/76	Fall-Weekday
	12 Midnight Oct. 29/76	12 Midnight Oct. 30/76	Fall-Weekend
	7:00 a.m. Feb. 18/77	6:00 a.m. Feb. 19/77	Winter-Weekday
	7:00 a.m. Feb. 19/77	6:00 a.m. Feb. 20/77	Winter-Weekend
4	12 Midnight Oct. 31/76	12 Midnight Nov. 1/76	Fall-Weekend
	12 Midnight Oct. 30/76	12 Midnight Oct. 31/76	Fall-Weekend
	8:00 a.m. March 10/77	6:00 a.m. March 11/77	Winter Weekday
	--	--	Winter-Weekend
5	11:00 p.m. May 26/77	10:00 p.m. May 27/77	Spring-Weekday

Table 2-1: Monitoring Schedule

3.0 RESOURCE INVENTORY
(NOISE ENVIRONMENT WITHOUT THE PROJECT)

3.1 PRESENT NOISE ENVIRONMENT

The present noise environment has been defined by a program of baseline monitoring described in Section 2.0 above. The complete information obtained is presented in Harford, Kennedy, Wakefield Ltd. Report 82-161-2 entitled "Baseline Noise Monitoring - Hat Creek Study" (See Appendix A). The most significant aspects of this data are presented below.

(a) Statistical Indices

The statistical indices measured include the $L_{0.1}$, L_1, L_2, L_5, L_{10}, L_{20}, L_{50}, L_{90}, and L_{99}. The measured L_{10}, L_{50} and L_{90} values are summarized in Table 3-1.

(b) Equivalent Energy Descriptors (L_{eq} and L_{dn})

The values of $L_{eq}(24)$ and L_{dn} obtained at each site are presented in Table 3-2. This table also contains values of the day average sound level, L_d and the night average sound level, L_n from which the L_{dn} and $L_{eq}(24)$ values were computed.

(c) Traffic Logs

Traffic counts were obtained for both day and night during the monitoring periods conducted in the valley (i.e. Sites 1 to 4). The 24-hour data is presented in Table 3-3. The data was obtained directly in some instances by the field engineer and in others by listening to tape recordings made during the monitoring. Where necessary due to gaps in the data, the traffic counts were normalized to 15 hours for daytime periods, 9 hours for nighttime periods, and 24 hours per day by direct scaling according to the hours of data available.

(d) Octave Band Data (background noise levels)

Octave band spectra were measured at various times of day during the fall and winter monitoring periods in the Hat Creek Valley. The range of levels measured at each site was plotted and these spectra are contained in Report 82-161-2 (See Appendix A).

(e) Discussion

Upon reviewing the noise data acquired, no consistent differences are apparent between fall and winter at any of the monitoring sites. At sites 3 and 4 where the noise environments are dominated by natural sounds, there was no significant difference between weekdays and weekends. Although the reported results indicate that the measured levels were higher on weekends at Sites 3 and 4, this is attributable to wind and rain which prevailed during the weekend monitoring. At Sites 1 and 2, it appears that noise levels are slightly higher on weekdays than on weekends probably due to increased truck traffic and, at Site 1, to more frequent operation from the nearby cement plant.

At Sites 1 and 2 (both on Highway 12), the noise environments are completely controlled by traffic noise. The day-night equivalent levels (L_{dn}) ranged from 44 to 51. At Sites 3 and 4, natural noise sources such as wind, rain and wildlife control the L_{dn} values which ranged from 32 to 41. At Site 5, the predominant noise source is train traffic although wind noise was of some significance on the particular day that the noise monitoring was conducted; the L_{dn} value measured was 56.

SITE	STATISTICAL INDEX (24 HOURS)	FALL		WINTER		SPRING
		WEEKDAY	WEEKEND	WEEKDAY	WEEKEND	WEEKDAY
1	L_{10}	37	35	41	40	
	L_{50}	29	25	34	29	
	L_{90}	25	24	27	24	
2	L_{10}	42	39	40	38	
	L_{50}	33	33	28	32	
	L_{90}	31	32	27	29	
3	L_{10}	25	32	24	26	
	L_{50}	21	28	19	19	
	L_{90}	19	26	18	18	
4	L_{10}	26	35	28	--	
	L_{50}	22	30	20	--	
	L_{90}	21	28	18	--	
5	L_{10}					51
	L_{50}					42
	L_{90}					37

Table 3-1: Values of L_{10}, L_{50}, L_{90}

SITE	STATISTICAL INDEX (24 HOURS)	FALL		WINTER		SPRING
		WEEKDAY	WEEKEND	WEEKDAY	WEEKEND	WEEKDAY
1	L_d	48	45	46	46	
	L_n	42	38	42	38	
	$L_{eq}(24)$	47	43	45	44	
	L_{dn}	50	46	49	47	
2	L_d	50	43	48	43	
	L_n	42	39	42	35	
	$L_{eq}(24)$	48	42	47	41	
	L_{dn}	51	46	50	44	
3	L_d	30	37	31	28	
	L_n	26	25	24	29	
	$L_{eq}(24)$	29	35	29	28	
	L_{dn}	33	36	32	35	
4	L_d	34	42	27	--	
	L_n	24	27	25	--	
	$L_{eq}(24)$	32	40	26	--	
	L_{dn}	34	41	32	--	
5	L_d					50
	L_n					49
	$L_{eq}(24)$					50
	L_{dn}					56

Table 3-2: Values of L_d, L_n, $L_{eq}(24)$ and L_{dn} (dBA) At the Five Baseline Noise Monitoring Sites

SITE	MONITORING PERIOD	CARS	TRUCKS	TOTAL	% TRUCKS
1	Fall Weekday	137	86	223	39
	Fall Weekend	174	54	228	24
	Winter Weekday	176	24	200	12
	Winter Weekend	180	25	205	12
2	Fall Weekday	203	114	317	36
	Fall Weekend	145	61	206	30
	Winter Weekday	121	35	156	22
	Winter Weekend	113	8	121	7
3	Fall Weekday	23	10	33	30
	Fall Weekend	17	2	19	11
	Winter Weekday	4	0	4	0
	Winter Weekend	6	1	7	14
4	Fall Weekday	5	0	5	0
	Fall Weekend	1	0	1	0
	Winter Weekday	0	0	0	0
	Winter Weekend	0	0	0	0

Table 3-3: Traffic Log for Entire Day (24 Hrs.)

3.2 FUTURE NOISE ENVIRONMENT WITHOUT THE PROJECT

This section discusses those factors which may cause changes in the environmental noise levels in the study region in the absence of the Hat Creek Project. The comments are restricted to those areas within the study region which could have their existing environmental noise levels significantly increased by the project, namely: the plant and mine sites and their environs and the areas surrounding major offsite facilities such as the make-up water pumping stations, the airstrip sites and the access road. Place names referred to are shown in Figure 3-1 and 3-2.

(a) Increases in Highway Traffic Volumes

(i) Highway 12

Traffic noise from Highway 12 controls the environmental noise levels at essentially all residences on Bonaparte Indian Reserves No. 1 and 2. Therefore, any significant increase in Highway 12 traffic volume will increase these noise levels. Strong Hall & Associates Ltd.[1] have reported that existing summer traffic volumes are about 400 vehicles/day near Pavilion and 600/day near the Carquile junction with Highway 97, and that firm projects that these volumes will grow respectively to 550 and 750/day by 1986 and 600 and 800/day by 1991. Provided the percentage of heavy vehicles, which is now quite high due to ore hauling, remains roughly constant, these increases in traffic volume will result in increases in environmental noise level of roughly 1.5 dB by 1986 and 2 dB by 1991. Such increases would be largely imperceptible even if they occured suddenly; spread over 10 and 15 years, they would be entirely unnoticed. Therefore, it is assumed that, for the foreseeable future, the increase in environmental noise at residences along Highway 12 without the project will be negligible.

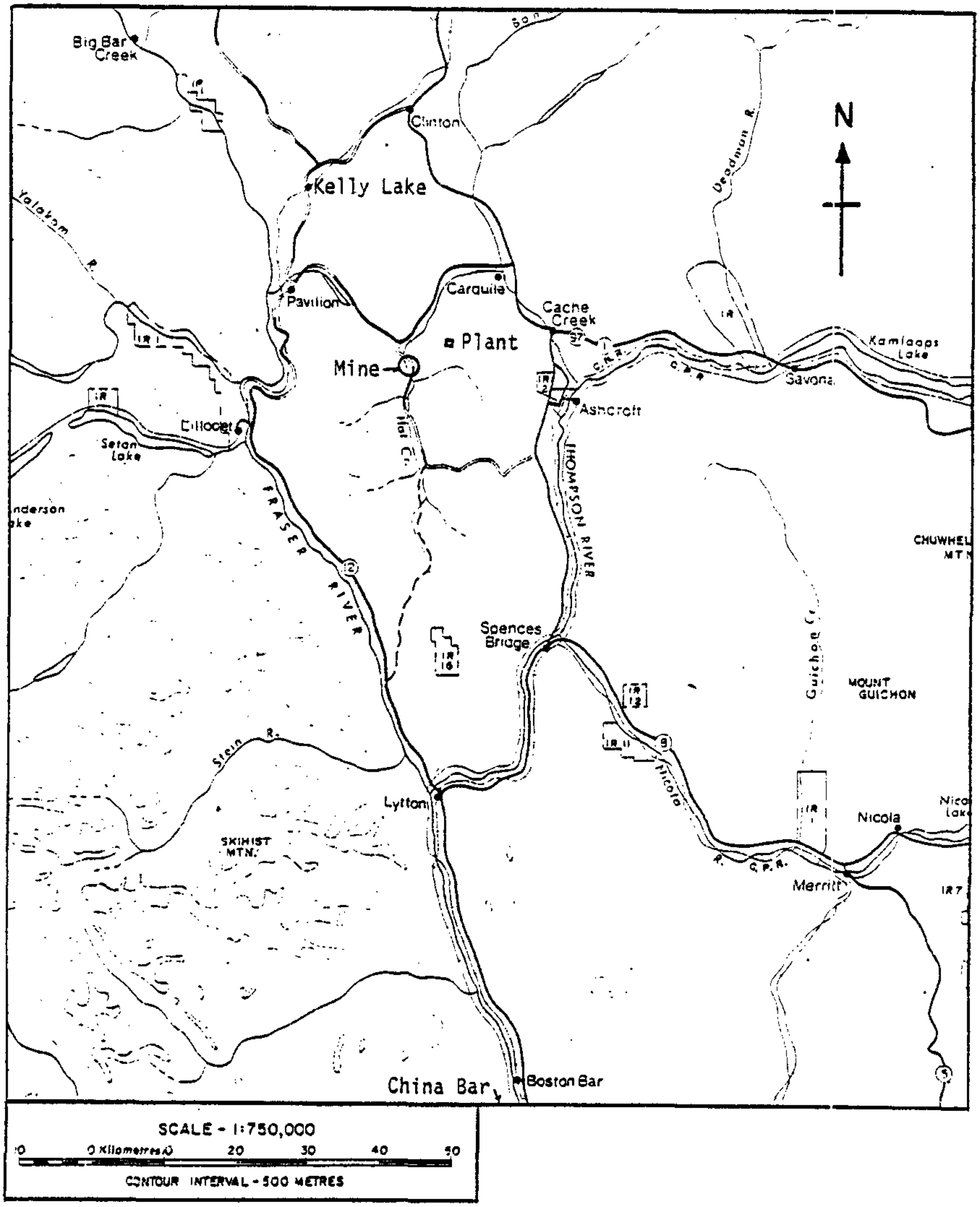

FIGURE 3-1: STUDY AREA SHOWING NEIGHBOURING TOWNS

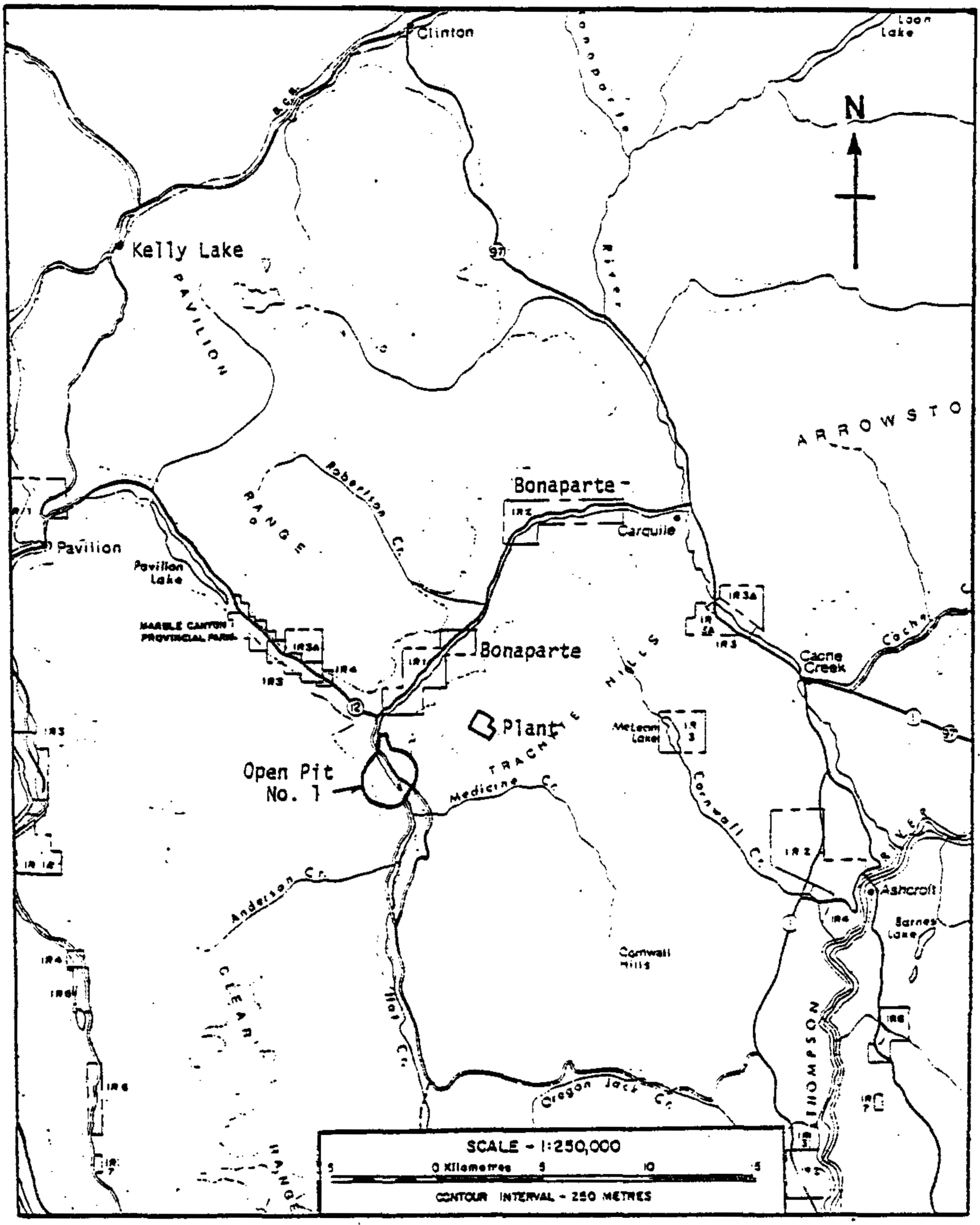

FIGURE 3-2: STUDY AREA SHOWING PLANT AND MINE SITES

(ii) Highways 1 and 97

Summer traffic volumes on Highway 1 near Savonna and at the China Creek Tunnel were about 8400/day in 1976; the corresponding figure for Highway 97 north of Cache Creek was 6700/day[2]. By 1991, Strong Hall & Associates predict these volumes will have increased to 15,500/day on Highway 1 and 11,500/day on Highway 97[3]. The completion of the proposed Coquihalla Highway in the mid 1980's would be expected to reduce Highway 1 volumes to their 1974 levels of 7000 to 8000/day.

Assuming the present percentage of heavy vehicles is maintained and the Coquihalla Highway is not built, the traffic noise levels along Highways 1 and 97 will, by 1991, have increased by approximately 3 dB and 2.5 dB, respectively. If the Coquihalla is completed by the mid 1980's and if the total traffic volume through the interior continues to increase by the rate predicted by Strong Hall & Associates, i.e. roughly 4900 vehicles/day per decade, it will take until roughly 2005 before the traffic noise along Highway 1 around Cache Creek will increase noticeably (about 3 dB) above present levels.

In summation, the historical rate of increase in traffic noise levels along Highways 1 and 97 from non-project traffic will be largely maintained but it will not be sufficient to significantly alter any possible project noise impacts suffered by receptors already exposed to this traffic noise.

(b) Increases in Railway Traffic

The environmental noise levels at the location of the make-up water intake and riverside pumping station just North of Ashcroft are presently controlled by train noise from both Canadian National (CNR) and Canadian Pacific Railway (CPR) mainlines.

Barring any significant changes in the type of trains using these lines or the whistle-blowing habits of their engineers, the train noise-controlled L_{dn} will increase by 3 dB for each doubling of train traffic volume. Current CPR predictions of rail traffic growth through Ashcroft[4] are for a steady increase from 1978 (25 train movements/day) to 1985 (32 movements/day). The current (1978) CNR average traffic volume is 22 movements/day with an anticipated growth of 10% or about 2 movements/day over the next 5 years[4a]. Extrapolating these growth rates, it is seen that it will take over 25 years for the train traffic volume to double and hence cause a barely noticeable increase in YDNL of 3 dB. Of course, now unforseeable developments could cause more erratic increase in rail traffic in the future, but it is conservative to assume that train traffic noise at Ashcroft will remain effectively constant throughout the life of the project.

(c) Population Changes

The level of environmental noise in a community increases steadily as the population density of the community increases. This increase results simply from the day to day activities of the inhabitants and the machines they use in their work and leisure. In the absence of major noise sources such as factories or freeways, the level of environmental noise can be estimated quite accurately solely on the basis of population density[5].

Two of the three major areas where existing human populations will be exposed to project noise are rural in nature and far from incorporated lands; namely, the Bonaparte Indian Reserve 1 and the Hat Creek Valley itself. Historically, the rural population of the study area is about the same as it was in 1941. This is because the rural growth has been close to existing communities and has been met with the extension of the boundaries of incorporated communities.[6] This trend is expected to continue so that it is unlikely that either the Bonaparte Reserve or the Hat Creek Valley would see significant population, and therefore, noise level increases, in the foreseeable future.

The third existing group of residents that may be impacted by project noise is located at the confluence of the Bonaparte and Thompson Rivers on land that is presently unincorporated but very near Ashcroft. At present about seven homes are located on a block of riverside land surrounded by a Class 1, Agricultural Land Reserve. It is not anticipated that any of this land will be freed for urban residential use[7]. The presence of the neighbouring land reserve and the shortage of good building sites near the river will, therefore, prevent any significant increase in the population density in this area. In addition, the existing environmental noise level (L_{dn} 56 at monitoring Site 5) is controlled by CPR and CNR train traffic so that a very substantial increase in population would be required to result in an increase in overall noise level.

(d) Changes in Land Use

If the Hat Creek project does not proceed, it is not foreseen that any significant changes in land use will occur in the Hat Creek Valley or on the Bonaparte Indian Reserve 1. The residents of the Hat Creek Valley have expressed their desire to continue ranching as many of the families have done for generations[8].

The current use of land around the proposed site for the make-up water intake at Ashcroft is not expected to change. The majority of the land is in the Agricultural Land Reserve, Class 1, and is not expected to be released in the foreseeable future. The small piece of residential land at the Bonaparte-Thompson confluence could be expected to grow somewhat in population but a change in land use is not foreseen.

The uninhabited areas in the Trachyte Hills surrounding the plant site are presently used for grazing and, particularly at the MacLean Lake Indian Reserve, for recreation. It is unlikely that these land uses will change in the near future. The noise levels created by these land uses, however, will likely increase slowly with time as more all-terrain vehicles replace horses as the means of transportation for both cattle tending and recreation. The effects of such changes in transportation methods on the environmental noise level (L_{dn}) cannot, however, be calculated, but they are not expected to be large.

To summarize, in the areas of potential project noise impact, there are no foreseeable changes in land use which will significantly influence the scale of that impact should the project proceed.

4.0 METHODOLOGY FOR PREDICTION OF WITH-PROJECT NOISE ENVIRONMENT

4.1 NOISE LEVEL PREDICTION METHODOLOGY

(a) General Philosophy

The many components of the Hat Creek Project will be located in an area of very uneven terrain and hence of shifting local surface winds. It is, therefore, not possible to model all relevant aspects of the facility and the surrounding atmosphere and terrain with sufficient precision to permit the total environmental noise levels from the project to be estimated with confidence. To be able to accurately evaluate the impact of project noise on local residents, it would be necessary to predict the project noise levels at their homes within about ±3 dB. Such precision is not attainable even with yearly-averaged noise levels.

For these reasons, a philosophy of "selective conservativism" has been adopted in the prediction of Hat Creek project noise levels. This means that where data and procedures with inherently high levels of accuracy are available, they have been utilized, but where the accuracy of data or procedures is low or where there is uncertainty as to the ultimate nature of project components, "conservative estimates" have been made. In this context, conservative estimates are those which lead ultimately to higher levels of noise at receptor locations.

A conservative approach as described above serves well to identify all aspects of the project which are not going to create impacts. However, where significant impacts are foreseen, successive conservative estimates may lead to the overstatement of their severities. It is the intention herein that the building up of such a margin of safety provides protection against random errors (see Section 4.1 c). The major conservative assumptions are summarized in Section 6.8, so that the inherent safety margins may be appreciated.

(b) With-Project Noise Level Descriptors

(i) Average Noise Level Descriptor (YDNL)

As discussed in Section 2.1, the day-night average sound level or L_{dn} is a widely accepted community noise level descriptor and it has been selected in this study as the descriptor by which comparisons of with and without-project noise environments are made. The baseline L_{dn}'s reported in Section 3.0 were obtained during 24-hour monitoring periods on weekdays and weekends during the fall and winter. These daily L_{dn}'s are considered to be indicative of the existing yearly L_{dn}'s (i.e. the logarithmic average of 365 daily L_{dn}'s) for the various monitoring sites.

The noise levels to be generated by the construction and operation of the project have been estimated in terms of yearly day-night average sound level which will henceforth be referred to as "YDNL". The YDNL's of all significant noise sources active within a given year are added together to obtain the total YDNL for a particular receptor location. Where reasonable estimates of intermittent noises levels have been possible, these have been added to the contributions of continuous noise sources.

(ii) Impact of Intermittent Noises

Compliance with YDNL criteria cannot, by itself, assure that project noise will have no impact. Infrequent, intermittent noises, of brief duration but relatively high level, can be a considerable source of receptor annoyance although they may make a small or insignificant contribution to the total YDNL to which the receptor is exposed. This is particularly true of nighttime noises. The appropriate noise level descriptor in this case is the peak A-weighted level (dBA) of the intermittent noise event and the annoyance can be expected to increase with the frequency of the events.

(c) The Accommodation of Error Margins

The estimation of environmental noise levels from a proposed project involves a chain of assumptions and calculations each accompanied by a degree of uncertainty or error margin. The error margins are additive throughout the chain of operations, however, as discussed in (a) above, the major uncertainties have been tallied on the conservative side. In this way, the cummulative margin of error is accommodated within a margin of safety.

(d) Sources of Sound Power Level Data

The first step in the prediction of community noise impact is to identify and enumerate the significant noise sources and obtain their sound power level characteristics, i.e. how much acoustic power they emit in operation. For fixed sound sources, such as fans, it is customary to obtain the total sound power level in dB relative to a reference power of 10^{-12} W. For mobile sound sources such as trucks, the sound pressure level at a given distance, usually 15.24 m (50 ft.) is used. For the purpose of combining various noise sources in this study, all sound power or sound pressure level data obtained has been converted to sound pressure level at a distance of 15.24 m (50 ft.) from the theoretical acoustic centre of the source region.

The three major sources of sound level data on project equipment have been:

1. manufacturer's literature or privately communicated test results,
2. measurements taken by Harford, Kennedy, Wakefield Ltd. of similar equipment in other operations,
3. semi-empirical models available in the literature based on many measurements of an equipment type.

Appendix B contains tables of sound pressure level data in Octave bands of frequency, from 31.5 to 8000 Hz, for all the significant noise sources (or similar pieces of equipment) identified in the Hat Creek Project. The sources of these data are also tabulated.

(e) Equipment Usage Factors

The proportion of time that a given piece of equipment is operated at partial or full load capacity is termed its "usage factor". Usage factors may thus vary from essentially 1.0 for continuously operating plant equipment to perhaps 0.05 for a seldom-used piece of construction equipment. In this study the usage factor of a piece of equipment is expressed relative to a time base of one year. For example, a compressor which operates 8 hours/day, 7 days/week for 3 months would have a yearly usage factor of $\frac{8}{24} \times \frac{7}{7} \times \frac{3}{12} = \frac{1}{12}$ or 0.0833. This usage factor would be applied to reduce the operating noise level of the compressor by 10 log (0.0833) or 10.8 dB to obtain its yearly "energy-averaged" noise level.

Values for equipment usage factors were obtained in various ways. For plant and mine operating equipment, the usage factors were largely dictated by the operating schedules. Common sense and some general comments in the literature[9] were used to fill in any information gaps. B.C. Hydro plant[10] and mine[11] descriptions provided the work cycles for many major pieces of mobile equipment. The approximate frequency of use of intermittent noise sources such as steam valves and pit blasting were obtained through discussions with Integ-Ebasco and B.C. Hydro engineers.

Construction equipment usage factors are more difficult to estimate. Data compiled by U.S. Environmental Protection Agency[12] for industrial and public words construction projects were used where applicable. Usage factors are provided by the EPA for the various major stages of a typical construction project so that the usage factors applied herein are generally averages of the EPA factors for those stages of construction which are applicable to a particular Hat Creek project component.

In many cases, project construction activities do not correspond closely to any of the construction categories for which the EPA gives usage factors. Here, conservative usage factors have been adopted, these being based on the assumption that all equipment will be active (i.e. under some load) for 75% of the construction hours that it is required to be on the site. For example, such a piece of equipment which is on a 5 day/week, 8 hour/day job for 6 months would have a yearly usage factor of:

$$\frac{3}{4} \times \frac{8}{24} \times \frac{5}{7} \times \frac{6}{12} = 0.09$$

(f) Sound Propagation Model

The degree to which sound is attenuated during its transmission from source to receptor depends in quite complex ways on the geometry of the source, the local meteorological conditions and the intervening terrain. Under ideal conditions, all of these factors can be taken into account with a reasonable degree of accuracy. However, in the relatively rugged terrain of the Hat Creek Valley, the attentuation to be obtained from some of these effects, although potentially large, becomes highly unpredictable. These effects will be present in many situations but the attenuation they produce will fluctuate widely in time and space.

Continuing with the policy of conservativism, it has been the practice in this study to neglect the most unpredictable of the sound-attenuating effects. The major sound-attenuating effects are discussed briefly below.

(i) Geometric Spreading

Geometric spreading refers to the progressive reduction in the intensity of sound waves as they move away from their point of origin. This reduction is inversely proportional to the increase in the total area of the wavefront. Therefore, for point sources — small compared to source/receptor distance r — the intensity decreases as $\frac{1}{r^2}$ while for line sources such as a busy highway, it decreases as $\frac{1}{r}$. These translate into decreases of 6 dB and 3 dB per doubling of distance respectively. When close to very large "distributed" source regions, such as the mine pit, the noise level will decrease much less rapidly but as r exceeds the diameter of the pit, the 6 dB per doubling rule will again take effect. See Appendix C, Section C1.4.

(ii) Atmospheric Sound Absorption

As a sound wave passes through the atmosphere, its energy is dissipated due to the viscosity of air and the vibrations induced in the oxygen molecules. The latter effect is dominant at normal temperatures and is strongly dependent on relative humidity and air temperature. In general, this attenuation increases rapidly with the frequency of the sound so that at large distances only the low frequency components remain audible.

Yearly average values of atmospheric absorption in dB per 305 m (1000 ft) were established by determining the seasonal average air temperature and relative humidity at various locations in the Hat Creek study area based on hourly average data for a one-year period (Dec. 1974 - Nov. 1975) contained in ERT Document P-5074-610[13]. The absorption values were then obtained from standard S.A.E. tables[14].

(iii) Wind and Temperature Gradient Effects

Friction between moving air and the surface of the earth causes positive wind speed gradients to exist in the first few hundred feet of the atmosphere. These gradients in turn cause sound waves traveling parallel to the earth's surface to be diffracted upwards or downwards depending upon whether the sound is traveling upwind or downwind respectively. The upward diffraction results in the formation of an acoustic shadow zone beyond a certain distance from the sound source and receptors in this shadow zone may experience excess sound attenuation* of up to 30 dB at some frequencies with 15 dB being a typical reduction in overall

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* Excess sound attenuation here means any attenuation experienced in addition to that due to geometric spreading and atmospheric absorption.

A-weighted noise level for fully-developed wind attenuation. Wind attenuation also occurs to a lesser degree in the downwind direction, this being due largely to atmospheric turbulence.

The amount of excess wind attenuation observed depends on wind speed and direction relative to the source-receptor path and on the source-receptor distance. Wind attenuation has been quantified for the situation of sound propagation over flat, even terrain between a source and receptor both near the ground[15]. However, in the hilly terrain of the Hat Creek region, these results cannot be applied directly because of the variation from place to place of both the wind gradient and of the height of the source to receptor path above the ground. They instead provide an upper limit to the wind attenuation that can be expected.

Based on the Average Wind Run Analysis Reports from B.C. Hydro weather stations in the Hat Creek region for the period November 1974 to September 1976[16], it was determined that at the large source-receptor distances that will be typical of the Hat Creek Project, the wind will be sufficiently strong to fully develop its sound attenuation potential for over 90% of the time. Hence, some degree of wind attenuation will exist for most noise sources for a great majority of the time.

To determine what the yearly average value of the upper limit (flat terrain) of wind attenuation was for the plant and mine sites, tables of monthly frequency of wind directions[17] from November 1974 to September 1976 were analyzed to determine the portions of the time that the wind blew from each quadrant of the compass. These time-weighting factors were then applied to the range of wind attenuations that would be generated in a given source-receptor path direction. The time-weighted attenuations were then averaged logarithmically, with the periods of calm winds (5-10%) considered to provide zero wind attenuation, to give average upper-limit wind attenuations values for a year.

In predicting the noise impact of the project components, wind attenuation has been neglected because of the uncertainty of its value over hilly and uneven terrain. The yearly average values of attenuation computed for flat terrain will then only be used to establish the degree of conservativism inherent in the predicted impacts (see Section 6.8).

Under normal daytime conditions, a negative temperature gradient or temperature lapse exists above the ground. This gradient causes sound waves to bend upwards in all propagation directions and hence a sound shadow can exists all around the source beyond a certain distance which depends on the strength of the gradient. At night, temperature inversions can cause sound to bend down to the earth. However, these effects are not as strong as wind attenuation and they only are fully developed under light wind conditions. For these reasons and because little data is available on the strength and distribution of temperature gradients in the Hat Creek Valley, this type of excess attenuation has been neglected in the noise prediction procedure.

(iv) The Ground Effect

Another type of excess sound attenuation can be caused by the destructive interference of two sound waves which reach the receptor via different paths; one directly from the source and the other after reflecting off the ground. The attenuation produced can be quite large (10 to 15 dB at mid frequencies) but the effect only occurs under very light wind conditions and when the sound waves travel close and at a grazing angle to relatively flat terrain.

The occurence of this effect in the hilly Hat Creek region will be highly unpredictable and restricted to the 5 to 10% of the time when the wind is calm or very light. Therefore, this effect has been neglected in the noise prediction procedure.

(v) Topographical Shielding

In the uneven terrain of the Hat Creek region, topographical features may be situated between a sound source and a receptor thus blocking the direct travel of sound between them. The attenuation resulting from this shielding increases with frequency and with the degree to which sound must divert from the direct source-receiver path. The attenuation has been calculated along those source-receptor paths affected using a modified Fresnel diffraction theory[18] for a point source of sound and a rigid, straight barrier.

(vi) Attenuation Due to Trees

The sound-attenuating ability of trees is often overestimated, the effect of a row of trees or a hedge being more psychological than acoustical. However, wide belts of trees of sufficient density can provide substantial high frequency attenuation. The trees in the arid Hat Creek region are generally too sparce and widely spaced to produce a significant effect. The high frequency noise components are generally adequately attenuated by distance and atmospheric absorption, thus the conservative stance has been taken again and tree attenuation neglected.

4.2 CONSTRUCTION NOISE LEVEL PREDICTION

The prediction of the noise levels produced by a construction project involved the following steps:

1. identify the yearly average number and, where possible, the make and model of each noisy piece of equipment for each year of construction.
2. obtain sound level data for each piece of equipment or an equivalent.
3. determine the usage factor of each significant piece of equipment from available data[19] or logical, conservative assumptions.
4. Combine the yearly average sound level (YDNL) from each type of equipment to get a total sound level and express this at a common reference distance.
5. project the total sound level out from the effective acoustic centre of the construction region to the surrounding receptor locations.

The above procedure was followed to obtain noise levels for all major plant, mine and offsites construction projects. However, in some cases it was possible to determine, without actually calculating the total project noise output, that the noise from a particular construction project will not produce a significant impact. These projects were deemed insignificant because they are to be executed simultaneously with other project activities which are of a larger scale or are closer to critical receptor locations.

In general, if a construction project is to last less than one year, its average noise level has been converted to a YDNL for the year in which the project predominantly falls. If a project lasts for significantly more than one year or if it is broken up into widely spaced work periods, then a YONL has been generated for each year or group of years having essentially the same level of activity.

Unless stated otherwise, construction work has been considered to be on a 5 day/week basis with a single, daily, 8-hour shift starting at 8:00 a.m.

Appendix B contains lists of significant construction equipment used to compute the total noise output of each major construction activity for the plant, mine and offsite facilities. Whenever possible, these lists have been obtained from the appropriate group responsible for the design of the facility in question. When no such list has been available, the equipment requirements have been estimated by comparison of scale and timeframe with other similar construction activities for which precise lists are available.

(a) Power Plant Construction

(i) Plant Proper

A. Equipment List and Construction Schedule

The numbers and generic types of construction equipment to be used during the plant construction years 1979 to 1986 were obtained from Integ-Ebasco "Hat-Creek Equipment Schedule" dated July 19, 1977. The numbers of equipment to be used in each major activity were averaged within each calendar year and the total numbers of each type of equipment for all concurrent activities within a given year were obtained. These total numbers included construction of the make-up water reservoir.

As much as possible the make and model of each generic equipment type was obtained from a list provided by Integ-Ebasco (Hat Creek Project - List of Representative Equipment). Where no make and model was specified a suitable unit was assumed based on the capacity specified or deemed appropriate.

Noise levels produced by the various significant pieces of equipment while under load were obtained from a variety of sources:

1. Measurements made at Island Copper (Utah Mines), Centralia Power Plant (Pacific Power and Light), Kaiser Resources and during the Bulk Sample Program.
2. Published noise levels for typical construction equipment - U.S. EPA Document EPA 550 / 9-76-004, Noise Emission Standards For Construction Equipment (Ref. 3),
3. Manufacturer's noise level data, privately communicated.

In Appendix B, the noise level spectra of all significant equipment are listed along with their sources.

B. Usage Factors

As discussed in Section 4.1e , the U.S. EPA has published typical usage factors for industrial and municipal construction equipment. However, no data is available for large public utility projects like Hat Creek. It was, therefore, conservatively assumed that all plant construction equipment would be under load for 75% of the construction hours for which its use is scheduled (See Section 4.1 e).

C. Steam Line Blow Outs

Prior to the initial start up of a unit, the steam lines are cleared of debris by blowing high-pressure steam through them and venting it to atmosphere. This process will have to be repeated roughly 10 times per day for 1 to 2 weeks until no more debris shows up in the vented steam. The duration of the individual blow outs vary from 3 to 10 minutes, so an average duration of 7 minutes has been assumed. It was also assumed that blow outs would only occur during normal construction hours.

Valve Specifications and Noise Levels

Operating steam conditions and valve sizes were supplied by Ebasco, Toronto, and the sound power level to be generated was estimated with a semi-empirical model (ref. 42). An etched steel plate will be fixed at a 45^{o} angle to the discharging steam to check for debris. The presence of this plate may increase the noise level created above that predicted by the model used herein, however the increase cannot be readily calculated. Therefore, a 3 dB safety factor has been applied to the blow-out noise levels.

Source Directivity

The blow out lines - one 79 cm. (24 in.) line for each unit - will most likely emerge horizontally from the east wall of the boiler house so that receptors to the west of the plant will receive very substantial shielding from blow-out noise. For receptors to the east, the blow-out noise will be essentially uniform and undiminished by plant shielding.

It is possible that the blow-out lines may be made to emerge from the west side of the turbine hall, in which case the shielding pattern discussed above would be reversed. This alternative is not desirable from the viewpoint of noise impact as the key receptor locations are to the west of the plant.

D. Variation of Plant Construction Noise Levels (1978 to 1986)

Figure 4 - 1 shows the variation of the quasi-continuous, A-weighted construction noise level with time from 1978-1979 to 1986. The noise levels are for the nearest plant property line (230m (750 ft.) west of the turbine hall) and are based on the assumption of a primary construction zone 370 m (1200) ft. in diameter centred on the boiler house. These noise levels would only exist during the 8-hour construction day. At night, from 1979 to 1983, the plant noise level would be controlled by construction transformer noise. These transformers will be located in the switchyard about 120 m (400 ft.) from the western property line so that the night-time noise level there will be about 48 dBA (see Section 4.3 c(vi)). Once the first generating unit comes on line in 1984, the nighttime noise levels will be controlled by plant operation. By 1986, with three units on line, plant operation will control the daytime noise levels as well. Figure 4.2 shows the location of the facilities described above.

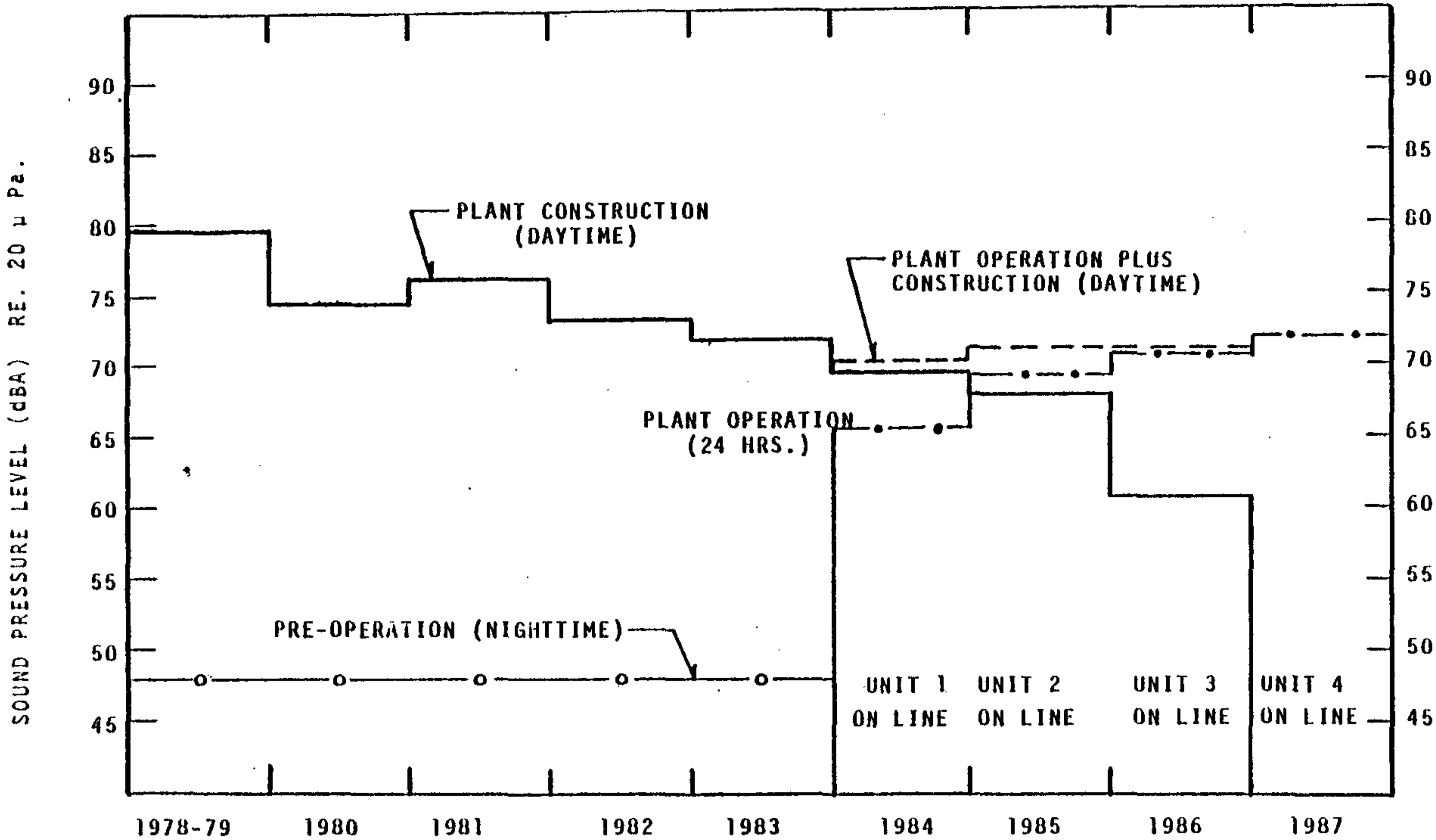

FIGURE 4-1: PLANT PROPERTY LINE NOISE LEVELS (dBA) FROM START OF CONSTRUCTION TO FULL CAPACITY OPERATION (WEST PROPERTY LINE, OPPOSITE SWITCHYARD).

HARFORD, KENNEDY, WAKEFIELD LTD.

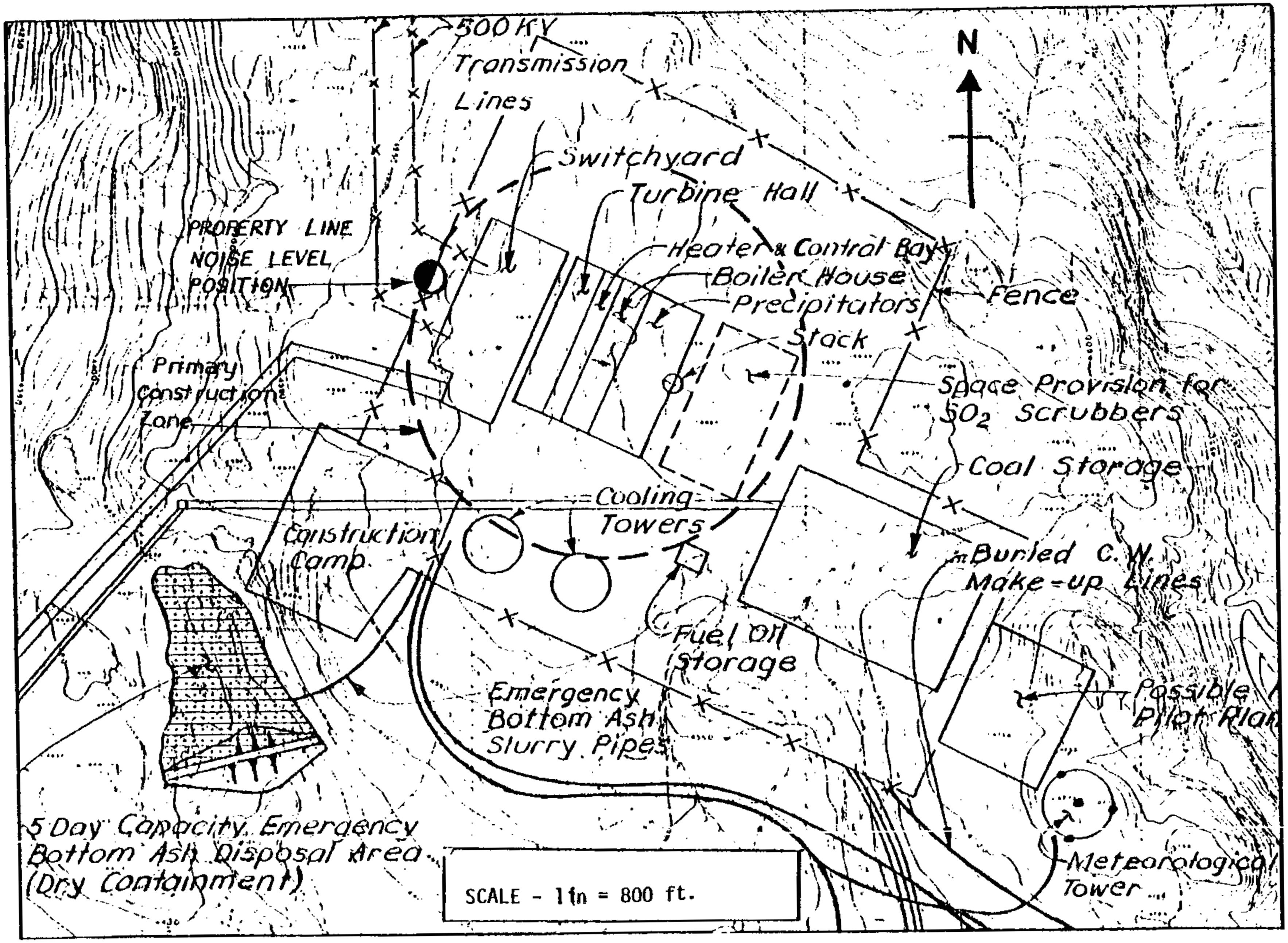

FIGURE 4-2: PLANT SITE SHOWING PRIMARY CONSTRUCTION ZONE
USED IN PREDICTION OF PROPERTY LINE NOISE LEVELS.

(ii) Power Plant Construction Camp

Although the construction of the power plant construction camp will preceed the start of actual power plant construction by almost one month, it will not make a significant contribution to the YDNL for 1979 for the following reasons:

1. much larger-scale construction on the boiler house foundation will begin immediately after the camp is finished,
2. according to H.A. Simons (International) Ltd. Report 4142A on Single Status Construction Camps, the buildings will likely be prefabricated and there will be minimum disturbance to the native ground cover.

(b) Mine Construction

For the purpose of noise impact prediction, the following have been considered to be mine construction activities:

1. the initial filling and levelling of the North Valley Dump in preparation for the mine mouth facilities,
2. the construction of the mine mouth facilities and the coal preparation for the mine mouth facilities
3. mine camp construction,
4. mine conveyor construction

(i) North Valley Dump Preparation

The filling of the North Valley Dump is actually the first phase of the removal of superficials from the mine, more precisely the main pit conveyor incline. However, since the northern half of the dump will provide the foundation for the mine mouth facilities, this portion of the dump-filling has been considered to be a construction activity in this report.

It has been assumed, in consultation with B.C. Hydro staff[20] that the necessary foundation material can be hauled and graded during the 6-month period prior to the scheduled July 1979 start of mine building construction. This work is assumed to be done with only that equipment listed for use during Stage 1 of the mine superficial removal operation in Table 14 of B.C. Hydro's August 1977 mining description. In keeping with Section 4.4 c (i) of the above mining description, it has been assumed that the scrapers and other equipment will work for 13.5 hours/day (daytime only - 7:00 a.m. to 10:00 p.m.) and 7 days/week. With a mean round trip haulage distance of 2 km. (1.25 miles) and an average speed of 16.1 km/h (10 mph), the scrapers will have a working-hour usage factor of approximately 0.8.

(ii) Mine Mouth Facilities and Coal Preparation Plant Construction

No construction equipment list was available for the mine buildings and coal preparation plant construction scheduled for the period July 1979 to December 1980. Therefore, use was made of the Mine Construction Work Force Estimate (Table 20W of the August 1977 Mining Description) to determine the amount of equipment required according to the number of operations required for various heavy machines, mainly cranes and trucks. Four or five air-compressors — which don't require operators — were also assumed to be in regular use. Usage factors were conservatively based on all equipment being under load for 75% of their construction hours.

(iii) Mine Camp Construction

Mine Camp construction is scheduled to begin in October 1978 and to continue for 8 1/2 months. For the first three months, this construction is the only major activity in the mine area and hence will control the noise impact at Bonaparte Indian Reserve 1. In January, 1980 North Valley Dump-Filling will begin and camp construction noise will become insignificant compared to the noise of the dump-filling operation.

To estimate the noise from the first three months of camp construction — the site preparation phase — a conservative equipment list was establised. It included one bulldozer, one grader, one backhoe, one loader and two dumptrucks; these being used primarily for site preparation and the installation of services. Usage factors were based on U.S. EPA data for public works construction projects.

The mine camp site examined was Site #1 which was designed as preferred by H.A. Simons (International) Ltd.[21] This site is approximately 760 m (2500 ft.) south of Reserve 1. All alternate mine camp sites are located so as to produce less noise impact on Reserve 1 that is Site #1.

(iv) Mine Conveyor Construction

While the construction of the pit incline conveyors and other conveyors to the waste dumps are major activities, they will not utilize large amounts of heavy equipment (mainly cranes and flatbed trucks). Furthermore, the conveyor construction is scheduled from May to December of 1981 so that it will be done, all or in part, while overburden removal and other mine mouth activities are underway. Therefore, it is believed that mine conveyor construction will not cause a significant noise impact.

(c) Offsites Construction

(i) Make-up Water Pipeline

Construction equipment lists and schedules for all phases of the make-up water pipeline were supplied by Sandwell and Company Ltd.[22] These activities, though temporary, are located quite near to existing residences and public buildings on the north end of Ashcroft, and hence have the potential to have considerable short-term noise impact.

A. River Bottom Preparation

The preparation of the river bottom prior to construction of the water intake may be necessary. This work is scheduled from November 1978 to April 1979. Usage factors for the equipment were based on the conservative, 75% of construction hours under load assumption.

B. Water Intake

Water intake construction is scheduled from August 1980 to May 1981. The intake requires the use of some unusual equipment in its construction such as a tugboat and several motorboats. Therefore reasonable, conservative usage factors were assumed for such equipment and the conservative, .75, value was assumed for other equipment such as loaders and compressors.

C. Pumping Stations

The construction of both the riverside booster station and the secondary booster station are assumed to take place concurrently from April 1981 to April 1982. The equipment list provided by Sandwell and Co. Ltd. applies to both stations. The existing noise environments and noise receptors are very different at the two station sites, however, so that the impact of the construction noise will not be the same for both stations. Equipment usage factors were generally based on the 75% of construction hours under load assumption.

D. Water Pipeline

There will be two phases to the pipeline construction. The first being right of way clearing which, for sections sharing the right of way with the access road or the 500 kV transmission line, will be done well in advance of the pipe laying. There will be little or no clearing required within the Ashcroft Village limits.

The second phase involves trenching, laying of pipe and backfilling all in rapid succession. The entire operation will be confined to a narrow strip only 0.4 km (0.25 miles) long at any one time. It is hoped that the pipe will be layed at the rate of 610 m/day (2000 ft/day) so that the whole operation will pass through the Ashcroft Village limits in less than a week.

The usage factors for the equipment used in the pipelaying phase were derived as much as possible from appropriate portions of the U.S. EPA data for streets and sewers projects. Where this data was notappropriate the conservative value of .75 was used.

Noise levels were not generated for the clearing phase since the extensiveness of clearing required was not known and some of it will be done as part of the access road and 500 KV transmission line construction. It would be quite conservative to say that, where substantial clearing is required, the noise will be the same as for the pipelaying phase.

The noise and vibration from blasting along the pipeline route and in other project construction activities will be discussed in Section 4.2 d .

(ii) Access Road Construction

An equipment list for access road construction was supplied by Sandwell and Co. Ltd. The construction will take place in two major phases, excavation and base course (October 1978 to December 1979) and surface course and paving (April to November 1979). It is likely that, in order to complete the road on schedule, four full crews will be required in the excavation and base course phase[23]. Therefore, it has been assumed that the quipment alloted for this phase will be divided equally among the four crews and that each crew will complete approximately 8 km (5 miles) of road. There will be only one paving crew. It will start at one end of the road (likely east) and work to the midpoint, with 12 highway dumptrucks hauling gravel and asphalt, and then move to the other end and start towards the midpoint again.

For the purpose of calculating the noise levels created by each of the four excavation and base course crews, the primary work zone of each crew is assumed to be a narrow strip 0.4 km (0.25 mile) long. Since the U.S. EPA does not provide usage factors for major road building projects, these were conservatively estimated as being generally between .5 and .75 based on observations made during the bulk Sample Program and calculations of mean haulage distances for trucks. The schedule calls for each crew to complete 8 km (5 miles) in about 14 months. Therefore, it will take a crew roughly 3 weeks to pass a given point. Noise from the primary construction zone of a crew will be audible at a given point for about 5 months.

The major source of noise impact from the surface course and paving phase will be highway dumptrucks hauling gravel and asphalt from the ends of the road. Since this is essentially a problem of traffic noise rather than of construction noise, a traffic noise model was used to predict the roadside noise levels. The model used for for this and other traffic noise predictions in this study was proposed in New Housing and Road and Rail Noise, Draft 2 by the Central Mortgage and Housing Corporation[24]. This document is expected to be adopted as a Canadian Standard in April 1978.

The actions of the other surface course and paving equipment were treated as a normal construction activity. Their usage factors are estimated in the same manner as were those of the excavation and base course equipment.

(iii) Airstrip Construction

Since no official equipment list was available for the airstrip construction, a list was compiled through comparison to that provided for the access road; the major activities of the two projects, namely base course preparation and surface course and paving, being largely the same. The comparison was made on the bases of total paved area and total construction time. Since the access road construction will generally be in much more rugged terrain than is the airstrip construction, thus making for slower work, the airstrip equipment list is likely conservative. The ratio of paved road area to airstrip area is 5:1 while the total construction time for the road is roughly twice that of the airstrip. Therefore, the numbers of equipment required for the airstrip is estimated to be $1/5 \times 2 = 0.4$ or 40% of the numbers required for the road.

The usage factors for the airstrip construction equipment were estimated in the same way as for the access road equipment.

(iv) Creek Diversion Construction

The several construction activities associated with the diversion of the Hat and other creeks have been ruled out as significant sources of noise impact for the following reasons:

1. The activities occur concurrently with the construction of the mine mouth facilities, the excavation of the pit incline and the filling of North Valley Dump. These other activities are nearer to Reserve 1 and will render creek diversion noise insignificant there.

2. Of the two presently inhabited dwellings that lie within the creek diversion area, one is located within the projected boundaries of the pit rim reservoir and hence will have to be vacated if construction proceeds. The other is within the boundaries of pit No. 1 and less than 1.6 km (1 mile) from the pit incline. Hence, if this dwelling is still occupied when construction starts, the incline excavation noise will dominate.

3. Of the presently inhabited dwellings in the Hat Creek Valley to the south of the creek diversion area, only one is in the range of possible impact by the diversion activities. This is the former Alan Parke property (recently purchased by B.C. Hydro) which is 1200 m (4000 ft.) south of the canal headworks — the most southerly component of the creek diversion complex.

(v) Offloading Facilities

The major construction activities associated with the offloading facilities will be the clearing, grading and gravel surfacing of the 3 ha.(7.5 acre) site. However, the precise locations of the facilities at the three alternate sites (Kelly Lake, Ashcroft and Spences Bridge) are not now available, so that specific impacts of construction noise cannot be determined. The three sites have been compared subjectively to determine their ranking in terms of probable construction noise impact.

(vi) 69 KV Transmission Line

The erection of wooden poles and the stringing of cable for the two 69 KV transmission line loops to serve the mine and the plant construction camp and the two make-up water pumping stations, will not be a significant source of noise. For Reserve 1 and Hat Creek Valley receptors, superficials removal and plant construction will overshadow transmission line construction as noise sources as will pumphouse construction for the receptors north of Ashcroft. For any receptors near Highway 1 east of Cache Creek, the stringing of the line will not cause a significant increase in the YDNL presently established by the highway traffic.

The noise from 69 KV transmission line construction is, therefore, judged insignificant and will not be analyzed further.

(d) Construction Blasting Noise and Vibration

Substantial amounts of blasting will be necessary in the excavation of the plant foundation and of the access road right of way. To a lesser degree blasting will be required for excavation of the water pipeline trench and pumphouse foundations and perhaps the airstrip and creek diversion canal.

The amounts of blasting required and the types and quantities of explosives to be used are not known at this time, so that a realistic prediction of construction blasting noise levels is not possible. As with the daily mine operation blasting [See Section 4.3b(iii)], the construction blasting will not likely be very significant to the YDNL due to the construction activities. However, because of the sudden nature of the noise and the possibly high peak levels accompanied by window rattling, construction blasting could be a cause of annoyance in some cases. Therefore, blasting activities in inhabited areas should be scheduled with regularity during normal working hours, and blasting noise levels should be monitored. Efforts should be made to minimize blasting noise and vibration as a general practice (see Section 7.0).

4.3 OPERATION NOISE LEVEL PREDICTION

It has been the purpose of this study to evaluate the Hat Creek Project's environmental noise impact and hence the noise levels within a project facility (building or boundaries) have only been of concern inasmuch as they influence the noise levels reaching the environment. In other words, the study has not been concerned with occupational noise exposure except in the case of very loud intermittent noise such as from steam venting which, as well as possibly creating annoyance or startle in the surrounding community, may threaten plant construction or operation crews with instantaneous hearing damage or severe startle. It has been assumed, based on the literature[24a] and on the experience of Ebasco's noise specialist[24b], that a reverberant noise level of 95 dBA will be attained throughout the interior of the boiler house and turbine hall. This level is felt to be indicative of noise levels attained in thermal plants in which largely "standard" equipment is used and the noise exposure of workers is controlled with personnel enclosures and hearing protection devices. It is recommended, however, that a goal of 90 dBA or lower be established during the detailed design of the plant.

(a) Plant Operation

The plant will be capable of operating in either the "base load" or "two-shift" modes. Base load would involve essentially full time operation while two-shift operation would involve nightly 6 to 9 hour interruptions as well as weekend shutdowns. However, at this time, an operating regime for the plant has not been clearly defined in terms of the relative durations of each mode of operation. Therefore, it has been conservatively assumed herein that, once a unit comes on line, it operates continuously for the life of the plant. This then represents the worst case situation that would exist during peak production years.

Since the dominant plant noise sources are duplicated with each boiler-turbine unit, as each unit comes on line the plant operation noise level is expected to increase by a factor of $10 \log_{10} N$, where N is the number of operating units. Therefore, the operation noise level will increase by 3 dB when Unit No. 2 comes on line and will have increased by a total of 6 dB relative to noise level of a single unit, when all four units are in service.

Plant operation noise can be characterized by essentially steady noise from combustion, power generation and air handling processes punctuated by intermittent, high-level noises from pressure relief valves and circuit breakers. The contributions of both the continuous and intermittent noise sources have been accounted for in obtaining YDNL's for plant operation.

Because the distance from the Harry Lake plant site to the nearest critical receptor locations on Reserve 1 is roughly two miles, the plant can be characterized accurately as a point source of sound. Therefore, the spatial arrangement of the various plant noise sources is only important so far as one source (e.g. the boiler house) acts as a barrier to the noise of another source.

(i) Significant Continuous Noise Sources

The following plant continuous noise sources were considered as being potentially strong enough to influence the overall YDNL of the plant as perceived by distant receptors. Therefore, these sources were subjected to a full quantitative evaluation of their levels, spectra and directivity effects. This is not to say that all the sources discussed below will contribute significantly to the plant YDNL. Those sources that do will be discussed further in later sections.

A. Boiler House and Turbine Hall Walls

Interior Noise Levels

It is not possible at the present stage of the plant design to predict the operating noise levels within the boiler house and turbine hall. Therefore, it has been conservatively assumed, on the basis of measurements taken by Ebasco in existing thermal power plants, that a level of 95 dBA will be attained throughout these buildings. However, it is recommended that a reverberant noise level of 90 dBA or lower be set as design objective in order to comply with Worker's Compensation Board of B.C. regulations throughout most of the plant. It is likely that in some areas of these buildings, the noise levels will be greater than 95 dBA but in other, possibly quite extensive areas, the levels will be considerably less than 95 dBA. Therefore, it is felt that the assumption of a 95 dBA incident sound level over the entire 89,500 m^2 (957,500 $ft.^2$) of the completed boiler house and turbine hall is conservative. The spectrum shape of the interior noise was taken to be that which would produce a total level of 95 dBA with approximately equal contributions from each octave band from 31.5 Hz. to 8 kHz[25]. See sample calculation in Appendix C.

Wall Construction

The design of the exterior skin of the boiler house and turbine hall has not yet been finalized. The "base" design as proposed by Integ-Ebasco[26] is a steel sandwich panel consisting of: exterior 22 gauge galvanized painted steel/3.8 cm (1.5 in.) glass fibre board of 26.4 kg/m^3 (1.65 lb./$ft.^3$) density/lighter interior steel sheet, likely 24 gauge. This base wall section has been used in the subsequent plant noise prediction. The sound transmission loss (i.e. the reduction in sound intensity across the wall) of this specific wall section was estimated using the field-incidence mass law[26a] as manufacturer's data were not available.

The transmission loss values so obtained at the critical low frequencies were very close to those available for other similar wall sections. (See Table B-8 & Appendix C, Calculation 1.) Alternate wall sections are being considered for use by the project architects, the main difference being in the thickness and type of cavity insulation material. For thermal reasons, a 5.0 to 6.4 cm. (2.0 to 2.5 in.) Urethane-filled wall is favoured. The effects on noise transmission of using other than the base wall are discussed in Section 7.1 b (ii) C.

Wall Openings

It is anticipated that equipment access doors will only be open for short periods during the final stages of construction of Units 2, 3 and 4 and during major maintenance activities. Furthermore, the doors will occupy only a small fraction of the total wall area of the buildings so that their opening will not significantly increase the total sound power radiated by the walls. Therefore, the effects of open doors are neglected.

Openings for the intake and discharge of combustion and ventilation air are in all cases directly coupled to the fans which move the air. Therefore, the dominant noise emitted from these openings is fan noise which will be dealt with separately.

Source Directivity

Because of the shape of the building (having an aspect ratio of about 3 to 1), a much greater wall area will face east and west than north and south and hence more sound will be directed to the east and west (approximately 3 times as much sound power or a 5 dB higher sound power level). Rather than try to account for this effect at distant receptor locations, it has been conservatively assumed that the higher sound power level will be radiated in all four directions.

8. Forced Draft (F.D.) and Primary Air (P.A.) Fans

Fan Specifications and Sound Power Levels

The test block conditions for the major plant fans were specified by Integ-Ebasco in their January 1977 power plant conceptual design[27]. These specifications were sent to Babcock & Wilcox Canada Ltd. who solicited sound power level information from five manufacturers of the axial flow fans anticipated for use in the plant[28]. This data is summarized in Appendix B. There were substantial variations in the reported noise levels of the various manufacturer's fans; over 30 dB in the some cases in critical low frequency bands.

To provide a check on the manufacturer's data, an empirical fan noise model from the literature[29] was applied. The noise levels predicted by the model generally were well within the scatter of the manufacturer's data except at 500 and 1000 Hz where the model's values were at the low end of the scatter range. The initial evaluation of the plant noise impact has been made using the worst case fan noise levels since it is not now known which manufacturer's fans will be selected.

Fan Noise Levels Emitted from the Plant

Each plant unit will have a fan room located against the east wall of its boiler house and containing two forced draft (F.D.) fans and two primary air (P.A.) fans. The intakes and discharges of both the F.D. and P.A. fans will be ducted to the top of the boiler house and to the boilers respectively with a minimum steel duct thickness of 6 mm (0.25 in). Fresh air will be allowed to flow into the boiler house through ground-level intake louvres set in the east walls of each fan room. Therefore, the noise escaping into the environment through these louvres will be controlled by fan casing radiation rather than direct fan intake or discharge radiation.

Fan casing-radiated sound power levels were supplied explicitly by one fan manufacturer (Novenco) and the differences between these levels and Novenco's fan inlet sound power levels were used as standard correction factors to approximate casing radiated levels for the other manufacturer's fans from their inlet levels.

The casing-radiated sound power levels from the four fans to be housed in each fan room were combined and the fan sound power leaving the boiler house through the air intake louvres was calculated. In this calculation the fan room walls and ceilings were assumed to be constructed of 10 cm. (4 in.) insulated steel sandwich panels with perforated inner facings to promote sound absorption[30]. The total sound power level radiated to the environment by the eight F.D. and eight P.A. fans in the entire plant is then 6 dB greater than the level calculated for one fan room.

Fan Noise Directivity

Because the ventilation air intake louvres will all be located on the east side of the boiler house, there will be substantial shielding from fan noise for receptors located to the west of the plant. The shielding to be provided by the boiler house was calculated using the modified Fresnel diffraction theory discussed in Section 4.1 f (v). While there will be some interference with the free-propagation of the Fan noise to the east due to the presence of the precipitators, the critical low frequency sound will pass between the precipitators with negligible loss in intensity.

C. Induced Draft (I.D.) Fans

Fan Specifications and Sound Power Levels

The test block conditions and manufacturer's sound power level data were obtained for the induced draft (I.D.) fans as they were for the F.D.and P.A.fans.

Fan Noise Levels Emitted from Stack

The I.D.fans (two per unit) will be located downstream of the precipitators and will discharge boiler exhaust gases into the 366 m (1200 ft.) stack. The ducts from the fans to the stack will have a minimum thickness of 6 mm (0.25 in.) and will be insulated with 10 cm. (4 in.) fibreglass and lagged[31]. In estimating the casing-radiated noise from the I-D fans, it was assumed that the fans and ducts will be lagged with an impervious material with a minimum surface density of 2.44 kg/m^2 (0.5 lb/ft.^{2})

In calculating the I.D. fan discharge noise levels which will emerge from the stack, the following sound attenuating factors were applied:

1. the reflection of sound at elbows downstream of the stack.
2. the wall absorption of the flues in the stack.
3. the atmospheric absorption over the 366 m. (1200 ft.) height of the stack.
4. the directivity of the sound emerging from the stack.

Stack (I.D. Fan) Noise Directivity

The first three of these attenuating factor have relatively small effects. The effects of stack directivity, however, can be quite large, especially for mid and high-frequency noise. At its top, the concrete stack will have an inside diameter of 20.8 m (68.3 ft.) and will contain four 7 m (23 ft.) diameter steel flues; one for each I.D. fan.

I.D. fan noise from the stack will be radiated uniformly in the horizontal plane, but will show considerable directivity in the vertical plane; i.e. sound will be radiated more strongly upwards than downwards towards the ground. This effect will be more pronounced at high frequencies than at low ones. In order to quantify these directivity effects, it is necessary to make simplifying assumptions about the nature of the sound field radiated from the four flues. The problem was addressed from two different points of view each with its own assumptions:

1. Consider that, after traveling up the great length of the large flues, all sound waves will be moving parallel to the axes of the flues. The rim of each flue will then act as a rigid, straight barrier to the emerging sound waves which will behave as if they were propagating freely (i.e. not confined by the flue) and will

diffract over the rim barrier. The directivity is then derived from simple barrier theory as described in Section 4.1 f (v). This directivity model is more accurate at high frequencies than at lower ones.

2. Consider that the top of each flue acts like a plane piston radiator (somewhat like a loudspeaker diaphragm) so that over the entire area of the flue opening, the sound is radiated in phase. The directivity of such a sound source can then be predicted from the theory of radiation from a vibrating piston set in a rigid sphere[32a]. This model is more accurate at low frequencies than at higher ones.

The ultimate directivity of the stack was obtained by adopting the lower of the directivity values predicted by the two models at each octave band frequency.

D. Transformers

Transformers Specifications and Noise Levels

Each 500 MW generating unit will have three single phase transformers with a rated capacity of 200 MVA at 500 KV. Measurements were made of the noise levels from a group of three transformers at Pacific Power and Light's Centralia Power Plant. These transformers had a rated capacity of 243 MVA at 500 KV. The noise level data obtained from Centralia is, therefore, expected to provide a conservative estimate of the Hat Creek transformer noise and was used directly. See Appendix 8 for octave band data. The Hat Creek transformers will be enclosed with either a low bank wall (for oil containment) or fire walls. They will not be enclosed to their full height on all sides[32]. Therefore, no shielding of transformer noise has been assumed.

Source Directivity

The transformers are to be located just beyond the west wall of the turbine hall. Therefore, the turbine hall and boiler house will provide very substantial shielding of transformer noise for receptors east of the plant. To the west, only the switchyard will be beyond the transformers, so that no shielding will occur in that direction. The Centralia transformers were similarly located against their main plant building and hence any reflection effects are accounted for in the noise levels adopted for the Hat Creek transformers.

Integ engineers have indicated that the Hat Creek transformers may be enclosed on all sides but not on top. However, in this analysis, no enclosure is assumed.

E. Cooling Towers

Cooling Tower Specifications and Noise Levels

The preferred plant design calls for two 116.5 m (382 ft.) hyperbolic (natural draft) cooling towers each with a circulating water flow of 20,200 litre/sec. (320,000 US gpm). Several semi-empirical models have been developed to permit estimation of natural draft cooling tower noise.. A recent paper[33] has shown that satisfactory agreement with measured data can be obtained from a model which predicts the near-field noise level (dBA) on the basis of water flow rate alone. This model has been used to predict the steady, A-weighted noise level from the Hat Creek cooling towers which are assumed to be of the counterflow type. The spectrum of cooling tower noise was based on the compiled measured data of several investigators presented in the above-mentioned paper (see Appendix C).

Source Directivity

The noise from hyperbolic cooling towers is uniform in the horizontal plane and it emerges mainly from the base of the towers where the cool air enters and the water droplets impinge on the fill material and water basin. As the towers are now planned to be located to the south of the boiler house, there will be some shielding of cooling tower noise for receptors to the north of the plant but this has been neglected in the present analysis.

F. Ash Disposal Schemes

Base Plant Scheme

The base plate scheme for ash disposal calls for the piping of both bottom and fly ash in slurry form to an Upper Medicine Creek disposal area. The noise produced by this scheme would be insignificant.

Alternate Scheme 1

Bottom ash would be sluiced to a separate disposal area near Harry Lake. Because of the limited capacity of this disposal area, some of the bottom ash may have to be trucked to the mine area for alternate use or disposal. The duration and scale of this possible operation are not now known, however, so that trucking noise estimates cannot be made. Certainly once the ash trucks approach the mine, their noise will be insignificant compared to the total mining noise.

Alternate Scheme 2

This scheme calls for the bottom ash to be either dewatered at the plant and conveyed to a disposal area near Harry Lake, or to be sluiced to a dewatering pond near Harry Lake and then trucked to a permanent dry disposal area nearby. According to Integ-Ebasco engineers[34], this latter variation would require four 100 ton trucks operating continuously over a 5 or 6 day week. If a front-end loader, a bulldozer and a grader are added to the trucks, the operation has the potential to increase the total plant noise levels experienced by receptors to the west by 2 to 3 dB under conservative, no-wind-attenuation conditions.

(ii) Other Continuous Plant Noise Sources

The following plant noise sources were identified but for various reasons were not considered to have the potential of being significant to the overall plant YDNL. They were, therefore, subjected only to less rigorous quantitative or purely qualitative evaluations and are listed here in the interest of completeness.

A. Precipitator Rappers

Precipitator rappers are devices which periodically jar the precipitators to loosen material extracted from the boiler exhaust gases. With all 8 precipitators operating, the resulting noise is quasi-continuous in nature. It is assumed that the rapper mechanisms will be enclosed, for both weather protection and noise reasons[35], with medium gauge sheet metal lined with a thermal-acoustic insulation. In this case, the rappers will not be a significant source of environmental noise.

B. Ventilation Fans

There will be a single centrifugal ventilation fan operating at 236 m^3/sec. (500,000 cfm) and from 0.5 to 1.2 kPa (2 to 5 in. w.g.) static pressure for each unit[36]. The fan rooms will be located on the west side of the turbine hall and will be constructed similarly to the F.D. and P.A. fan rooms. The sound power levels to be generated by these fans were estimated using an empirical model in the literature[37]. Upon converting these power levels to noise levels outside the fan room intakes, the ventilation fans were seen to be insignificant noise sources.

C. Cooling Tower and Make-up Water Pumps

Each cooling tower will be supplied by a 3.73 mW (5000 h.p.) pump. Three 0.746 mW (1000 h.p.) fire protection and make-up water pumps will be located at the reservoir. Both types of pumps will be fully enclosed in pumphouses[38] and, therefore, are not considered as significant environmental noise sources.

D. Coal Conveyors and Transfer Points

All coal conveyors and transfer points between the mine and the plant will be enclosed for weather protection and dust control reasons. Also, well-maintained belt conveyor systems are not inherently noisy. Therefore, they are not considered as significant noise sources.

E. Coal Storage and Reclaiming Facilities at the Plant

The possibility of a coal storage area at the plant exists. However, based on measurements taken by the consultants at Robert's Bank coal terminal, this operation would not be a significant plant noise source [see Section 4.3b(i)C].

(iii) Significant Intermittent Plant Noise Sources

The following plant noise sources have the ability to produce very intense sound for relatively brief periods. They were considered to have the potential to contribute significantly to the overall plant YDNL. The frequency weighting applied to those intermittent noises which are truly impulsive (typically less than 1.0 sec. duration) will depend on their level[39]. If the peak level of the impulse at a given receptor location is greater than 105 dB, the C-weighting has been applied, if it is less than 105 dB, the usual A-weighting has been used. In either case, the resulting intermittent noise contributions for a given year have been added to those of the continuous noise sources in computing the total YDNL.

A. Electromatic Relief Valves

Each unit boiler will be fitted with two electromatic relief valves which will be designed to open when boiler pressure exceeds the normal operating level and release steam to the atmosphere. The frequency of such steam ventings cannot be predicted accurately but based on the experience of Ebasco Services Inc. New York, with a valve setting of 345 to 480 kPa (50 to 70 psi) above operating pressure, the likely frequency is about four times per year per unit or a total of 16 ventings per year for the plant[40]. This figure does not anticipate the venting of steam as a regular part of plant load reduction. The ventings were considered to occur at random, i.e. equal likelihood of day and nighttime venting, and have an average duration of 15 s.

Valve Specifications and Noise Levels

The steam conditions (maximum temperature and pressure) upstream of the valves and the valve size were obtained from Ebasco, Toronto Office [41]. The sound power level to be created by the escaping steam was predicted using a semi-empirical model which applies to gas venting in general and utilizes the following parameters: gas temperature, pressure and molecular weight and valve flow area [42].

Source Directivity

The discharge pipes which direct the vented steam out of the boiler house to the atmosphere will be located on the boiler house roof and will be directed vertically[43]. There will, therefore, be some preferential sound radiation into the upward hemisphere, however, this has been neglected in Calculating the noise levels radiated into lower hemisphere (toward the ground). The flat roof of the boiler house will provide some shielding for ground level receptors in most, if not all directions (depending upon exact discharge positions on the roof).

B. Circuit Breakers

At full capacity, the plant will have 14 three-pole, 500 kV air-blast circuit breakers. They are to be CGE type AT or equivalent. Integ-Ebasco estimates that 60,000 operations of two breakers simultaneously will occur during the 35 year life of the plant[45] or roughly 1720 operations per year.

Specifications and Noise Levels

Noise level data was not available from CGE so that data from a recent IEEE paper[46] for a 400 kV pressurized-head, air-blast circuit has been used. This reference gives a sound pressure level of 160 dB peak linear at 15 m (50 ft.). This level is roughly 18 dB higher than that measured recently at B.C. Hydro's Mica Creek installation of Brown-Boveri 500 kV breakers and is therefore felt to be conservative. The frequency spectrum of circuit breaker noise assumed is given in Appendix B, Table B-6.

For the purpose of calculating the contribution of circuit breaker noise to total YDNL at receptor locations, it was conservatively assumed that the duration of the breaker impulse noise between the 10 dB down points is 100 ms. It was also assumed that the breaker operations would be equally probable at night as in the daytime.

Source Directivity

Circuit breaker noise will be essentially omnidirectional. However, the boiler house will provide some shielding for receptors located directly east of the plant.

(iv) Other Intermittent Plant Noise Sources

The following intermittent plant noise sources were, based on qualitative arguments, not considered to be potentially significant contributors to the overall plant YDNL. They are listed here in the interest of completeness.

A. Disconnect Switches

The switchyard will contain 28 disconnect switches — 14 manually and 14 motor operated — ITE TYPE TTR 70 C or equivalent. These switches do not operate on the air-blast principal and, therefore, are not considered to be significant noise sources.

8. Plant Public Address System

The plant public address (P.A.) system will cover the immediate plant vicinity plus one small area of each of the following locations: ash dumps, make-up water pumphouse at the plant reservoir, cooling tower pumphouse, and plant coal stockpile[47]. In situations where residences are located near a plant in a rural or suburban setting, P.A. systems are often serious sources of annoyance because they must, to be useful, be clearly audible above the background noise of the plant.

In the present situation, where the nearest residence is over 3.2 km (2 miles) from the plant, the plant P.A. system is not likely to be a source of annoyance to residents. However, efforts should be made in the design of the P.A. system to restrict its coverage to those areas where it is required (see Section 7.0).

(b) Mine Operation

During its production life, the coal mine (open pit, coal preparation facilities and waste dumps) can be considered as a quasi-continuous noise source; that is, the noise output of individual pieces of equipment may fluctuate greatly, but the aggregate noise output of all noise sources will remain relatively constant, 24 hours per day, 7 days per week. This quasi-continuous noise will be punctuated by periodic high-level impulsive noise from blasting.

The numbers and generic types of mobile mining equipment to be used during the various stages of mine operation were obtained from Table 14 "Schedule of Mobile Mining Equipment Requirements" in B.C. Hydro Mining Department's Hat Creek Mining Project Engineering Description for Environmental Report.

Usage factors for major types of mobile mining equipment were estimated in the above Hydro mining description (Section 4.4c) based on mean haulage distances and vehicle speeds and a general availability factor of 75% was assumed for such equipment.

The noise level data for mobile mining equipment was gathered from a variety of sources, as with construction equipment (see Section 4.2a), and is listed in Appendix B.

(i) Significant Quasi-Continuous Mining Noise Sources

A. Pit Operations

For the purpose of noise estimation, pit operations have been considered to include coal extraction and pit waste and segregated waste removal. All pit operations are considered to take place below the original level of the valley floor so that some degree of shielding is provided by the pit walls.

Characterizing the Noise Source Region

As discussed in Section 4.3 a , the entire plant, because of its distance from critical receptors, can be represented as a point source of sound. The diameter of the open pit, by contrast, is greater than the distance from the northern pit rim to Indian Reserve 1. Therefore, portions of Reserve 1 are in the acoustic near field of the pit and the spatial extent of the pit must be accounted for in the estimation of the noise levels it creates at Reserve 1 and other nearby receptor locations.

The pit must then be considered as a distributed sound source region dotted with many individual noise sources which are more or less continuously moving and varying their noise output. The levels of accuracy of the equipment noise level data and usage factors, the sound propagation model and indeed the entire noise impact procedure did not warrant the rigorous mathematical analysis of this complex noise source. Therefore, a simplified model of the pit as a noise source was devised based on the following assumptions:

1. The mobile equipment will work predominantly on the ever-expanding face of the pit; they will travel and work in concentric circles around the entire pit circumference except for the portion occupied by the conveyor incline.
2. Over the period of a year, on which YDNL is based, the mobile equipment will distribute their work hours uniformly over all working faces of the pit, from top to bottom and through essentially 360°.
3. The mobile mining equipment can, therefore, be considered to create a uniformly distributed noise source over the entire area of the pit when considered on a yearly average basis.
4. The pit is considered to be symmetrical and, therefore, the distance from a receptor location outside the pit to the effective acoustic centre of the pit as perceived by the receptor, can be approximated by integrating, across the pit diameter, an expression for the acoustic intensity of a point source as a function of distance. Once the effective acoustic centre of the pit has been located for a given receptor location, the total sound power of all mobile mining equipment can be considered to be concentrated at that centre and the pit can be treated as a simple point or line source, depending on receptor distance. An example of this procedure is given in Appendix C.

Pit Wall Shielding

Once a piece of mobile equipment enters the pit and goes below the existing level of the valley floor, its noise level as perceived by a receptor on the valley floor will be reduced due to shielding by the pit walls. The deeper the equipment goes into the pit, the greater the shielding. There will be 15,12-metre (40-foot) high, terraces from the valley floor to the bottom of the 183 m. (600 ft.) deep pit. To arrive at an average pit wall attenuation, it was assumed that an equal number of equipment hours will be spent on each terrace; this becomes more accurate as the pit expands. The barrier attenuations were then calculated for each terrace level using a simplified Fresnel diffraction theory, and the attenuations were averaged logarithmically to yield yearly average values for the entire pit. This procedure was carried out for receptors to the north and south of the pit and was based on the anticipated mine configuration during Stage 5; Stage 5 occuring roughly in the mid years of the mine's life and its configuration providing roughly average values of pit wall attenuation.

8. Superficials

The removal of superficials (overburden) will be largely carried out by scrapers which, in the initial stages of mine development and operation, will haul material directly to the dump areas. When haulage distances become prohibitive, the scrapers will deposit the material into hoppers at the top of the pit incline for direction to the dumps via conveyor[48]. In both types of operations, the scrapers will stay at or near the surface of the pit and, therefore, pit wall attenuation will be negligible.

Since the superficials operations are anticipated to proceed continuously all around the rim of the pit, the effective acoustic centre located for the pit operations will also be considered to be the point of origin of superficials noise.

C. Coal Preparation Facilities

The coal preparation facilities, while quiet compared to the pit and superficials operations, are of concern because of their proximity to Reserve 1. The location of the coal preparation area has been assumed to be that given on B.C. Hydro Preliminary Project Layout, Drawing No. 6044-C14-E7, December 1, 1977. This layout places the northern edge of the coal preparation area 244 m. (800 ft.) from Reserve 1. The major noise sources in the area are the coal stacker and reclaimer and their associated conveyors and mobile clean-up equipment as well as the primary and secondary crushers.

Coal Stacker and Reclaimer

An essentially continuous coal stacking, blending and reclaiming operation will go on throughout the life of the mine. This will be accomplished by a radial stacker and a bucket-wheel reclaimer operating simultaneously. It was confirmed by Cominco-Monenco Joint Venture[49] that the existing stacker-reclaimer at Roberts Bank coal terminal (Stephens-Adamson, 4000 tons/hour) is indicative in type and capacity of those planned for Hat Creek. Therefore, measurements were made of the noise levels generated by the Roberts Bank installation in the reclaiming mode. These levels are expected to be marginally higher than those during stacking when the bucket-wheel is idle. The octave band noise levels so obtained are given in Appendix B.

Mobile Clean-up Equipment

It has been estimated that two or three dozers or loaders will be required on a full time basis to clean up the coal piles during reclaiming[50]. It has, therefore, been assumed that one Cat D8K dozer and two Cat 966C loaders will operate with usage factors of 0.75. The shielding generally provided by 15 m (50 ft.) high coal piles has been accounted for.

Primary and Secondary Crushers

The primary and secondary coal crushers will probably be located near the main conveyor interchange [1300 m (4260 ft.)] south of Reserve 1(according to Cominco-Monenco Drawing No. 620-001, October 26, 1977) but it could possibly be located in the pit. The former situation will be addressed here as it would result in higher noise levels at Reserve 1.

The two crushers will be enclosed in a single crusher house[51]. Typical noise levels inside a modern crusher house were obtained from a recent report prepared for the U.S. Bureau of Mines[52]. The size of the crusher house was estimated from Plate 32 of B.C. Hydro's August 1977 Mining Project Engineering Description. The wall construction was assumed to be the same as planned for the plant boiler house [see Section 4.3 a (i)A].

The recrusher (for crushing coal reclaimed from the stockpiles) has been assumed to be similarly enclosed.

Coal-Washing Alternative

It may prove necessary to wash (wet beneficiation) a certain portion of the coal in order to meet air quality standards. No data is yet available on the type of process or amount of coal washed. However, it is assumed that the washing facility would be enclosed and, based on noise levels reported for other coal-cleaning operations, that its noise would be insignificant compared to that of other coal handling facility activities[53].

(ii) Other Continuous Mine Noise Sources

A. Waste Dumps

The noise-generating equipment to be employed during the operation of the two major waste dumps (Houth Meadows and Medicine Creek) is limited to a side-boom tractor to move conveyers and two or three pieces of mobile equipment to prepare embankments and contour the waste[54]. Compared to the levels of activity involved with pit excavation and superficials removal, the waste dump activities will be insignificant sources of noise. The Houth Meadows dump, although somewhat nearer to Reserve 1 than the pit, [distance to acoustic centre of dump is 1830 m (6000 ft.) compared to 2800 m (9200 ft.) for the pit] will be an insignificant source relative to the combined noise generation of the coal preparation facilities and the pit and superficials operations.

B. Conveyors

Conveyors will carry coal and waste out of the pit and carry coal to the plant and wastes to the dump areas. However, all fixed surface conveyors will be enclosed for weather and dust reasons[55]. In addition, rubber-belted conveyors are not inherently noisy[56] and their noise is primarily mid and high-frequency, which will not propagate as efficiently as low-frequency diesel equipment exhaust noise for example. Conveyors are, therefore, not considered to be significant noise sources.

(iii) Intermittent Mining Noise Sources

A. Blasting Noise and Vibration

Blasting Noise

Blasting will be a regular part of the mining operation. Because of the need to shut down operations and vacate the blast area, B.C. Hydro Mining Department would like to blast as infrequently as possible. The maximum frequency would be one blast per day and the desired minimum frequency is 1 to 2 blasts per week. Since the size of a weekly blast must be roughly seven times that of a daily blast, the difference in contributions to YDNL — since all blasting is to be done in daytime — between these two extreme cases is small. The daily blast case gives a slightly higher YDNL, so therefore it has been assumed herein. As discussed in Section 4.3 a (iii), where intermittent noise levels have exceeded 105 dB, their C-weighted spectra have been applied to calculate YDNL, otherwise the A-weighted spectra have been used.

Peak blasting noise levels were calculated from a semi-empirical model[57] in which the main parameter is the weight of the explosive surface charge, as it is the surface charge (i.e. primer cord), rather than the charge in the holes, that generates the most noise. B.C. Hydro's Mining Department estimates that the blasting program will consume 3000 m/week (10,000 ft./week) of primer cord containing 82 grams/m (25 grains/ft.) of PETN explosive[58] .

Blasting Vibration

The treatment of the impact of project-created ground vibration is not strictly in the terms of reference of the noise study. However, since sufficient information is available to estimate the range of vibration levels to be expected from the major source, mine pit blasting, this has been done. This analysis and its conclusions are contained in Appendix E.

B. Mine Public Address System

Because of the nearness of the mine and coal preparation facilities to Bonaparte Reserve 1, the mine public address system has a greater potential for creating annoyance than does the plant system. Although the levels of noise from this P.A. system at Reserve 1 may be below that created by diesel-powered mining equipment, the frequency and information content and the intermittency of the P.A. system noise may make it clearly audible and hence annoying, especially at night. P.A. system noise levels cannot be predicted at this time, but for the reasons given above, measures should be taken to confine this noise to the project areas for which it is intended. (See Section 7.) A criterion for P.A. system noise levels is given in Section 5.2 d.

(c) Offsites Operation

(i) Make-up Cooling Water Supply System

The make-up water intake and riverside booster pumping station are to be located near the confluence of the Bonaparte and Thompson Rivers just north of the Ashcroft Village limits. There are several homes within 300 m. (1,000 ft.) of this pumping station and intake. The second booster pumping station will be located 7 km (4.5 miles) along the pipeline at an elevation of 850 m (2,800 ft.) in an uninhabited area.

A. Booster Pumping Stations

Sandwell and Company Ltd. has reported[59] that all pump and motor manufacturers state that their equipment (namely five 2,600 kW (3,500 h.p.), high pressure pumps and ancillary equipment) can meet the 90 dBA Worker's Compensation Board limit in the pumping station interiors. In calculating the YDNL's near these generally unmanned stations, it has been assumed that the 90 dBA interior level will be achieved, however, it is recognized that it may not be necessary to achieve this level for either occupational or environmental noise reasons. The spectrum shape of the interior pumping station noise was estimated from data provided to Sandwell by the Byron Jackson Pump Division of Borg Warner.

The construction of the pumping station walls and roof was described by Sandwell[60] and consists of a steel frame with precast concrete wall panels and steel roof deck with inverted membrane assembly. Perforated steel "sandwich" panels would be used to provide interior sound and thermal insulation as requirec.

Other sources of operating noise at the booster pumping stations will be : the transformers (20 MVA, 69 KV/4.16 KV - one at each station)[61] and the ventilation fans (one 10 h.p. axial fan in each end wall of the pumphouse)[62].

Noise levels for the transformers were obtained from B.C. Hydro Stations Planning. Since fan selections will not be made until the detailed design phase, a worst case noise level has been adopted for axial fans in the 10 h.p. class.

B. Pipeline

The only significant noise associated with the operation of the water pipeline will be that from maintenance and inspection crews. It is not possible to estimate this noise at this time but it is likely to be insignificant to the local YDNL unless major maintenance is required.

C. Water Intake

The river water intake walls and roof will be constructed in the same way as for the booster pumping station. According to Sandwell Report V4191/1, March 1978, Volume 1, the intake building will house five vertical-turbine style pumps of 185 kW (250 h.p.) each. By comparison, the five booster station pumps will be 2600 kw (3500 h.p.) each. Furthermore, the intake building will not have any exterior-mounted ventilation fans or any associated transformer.

River water intake operating noise is, therefore, judged to be insignificant compared to that of booster pumping station 1 and will not be considered further.

(ii) Airstrip

In the foreseeable future, the traffic at the new airstrip will be very light. B.C. Hydro estimates a maximum of 3 flights/day [63] (6 movements/day) directly associated with the construction of the plant and likely fewer once the plant is in full operation. The present volume of local traffic at Ashcroft is not known, but it was determined that at Ft. St. James where the level of aircraft activities is higher, there are approximately 600 itinerant movements (300 visits) and 300 local movements per year[64].

On the basis of the above information, aircraft noise levels at the proposed strip were predicted for an initial traffic volume of 8 movements/day (4 take offs and 4 landings) with all movements occurring during the daytime. Six of the aircraft movements will likely be with small aircraft typified by the Cessna 150 and the other two with B.C. Hydro's MU-2. The procedures used to obtain the L_{dn} contours to be generated around the airstrip by these flights were as developed in a study of aircraft noise at Vancouver International Airport[65]. This procedure takes into account the type, airspeed and rate of climb of the aircraft. (See Appendix C).

At the preferred airstrip site (Site A), Highway 1 is 1500 m (4900 ft.) away so that the existing noise levels are very low. The area is uninhabited. The alternate site (Site C) is only 60 m (200 ft.) from Highway 12, so that the local residents already experience quite high road traffic noise levels.

(iii) Access Road

A. Project-Associated Traffic

The new access road will be 31 km (19.5 mile) long, have a design speed of 80 km/h (50 mph) and grades of up to roughly 8%. Estimates of access road passenger car traffic directly associated with the construction and operation of the plant and mine were supplied by Strong Hall & Associates [66]. These figures varied from about 1400 movements/week in 1980 to 3900 per week during the peak construction year of 1983 to 2700 per week during operation (1988-90). Heavy truck traffic data was limited to estimates provided by B.C. Hydro of trucks supplying materials to the plant site during peak construction years (40-60 movements/day)[67]. It was conservatively assumed that during operation of the plant, there would still be 20 truck movements/day. Passenger vehicle traffic will occur predominantly during the day except for those people on the graveyard shift. Truck traffic has been assumed to be all during the day.

B. Non Project-Associated Traffic

Some local, tourist and commercial traffic going to or from Pavilion or Lillooet will no doubt find it more direct to use the new access road instead of Highway 12. It has been assumed that 20% of the traffic which would otherwise have used Highway 12 will use the access road. Figures for the present and future Highway 12 traffic without the project were supplied by Strong Hall & Associates [68].

C. Traffic Noise Model

The basic YDNL's for the access road traffic were predicted using a model prepared for the CMHC by the National Research Council[69]. This was done by computing the L_{eq} for the day and for the night and combining them — while applying the +10 dB nighttime weighting — to give L_{dn}.

To obtain the YDNL's for a specific section of access road, a correction for road grade was applied and where necessary, any topographical shielding was accounted for.

(iv) Creek Diversions

The operation of the creek diversion facilities is not expected to be a significant source of noise. Those pumps required to move the water will be enclosed in pumphouses.

(v) Equipment Offloading Facilities

There are three locations being considered for the equipment off-loading facilities, each on a different railroad: BCR-Kelly Lake Substation, CNR-J & B Lumber near Ashcroft and CPR-Spences Bridge. However, the details of location are not yet available so that noise levels at receptor locations cannot generally be quantified. Since all sites are near existing rail lines and/or spurs, the impact of the offloading yard itself is not expected to be very significant. At Ashcroft, for example, (the most sensitive site), the 1978 CPR rail traffic is expected to be 24 movements/day. The corresponding CNR traffic is 22 movements/day[70]. The operation of the off-loading facility will require cars to be shunted into the yard twice per day[71]. Hence, the extra train movements for equipment offloading will not be significant to the total train noise.

The major noise impact is expected to arise from the trucking of materials away from the facility. B.C. Hydro estimates that up to ten semi-trailer trucks will enter and leave the terminal during a normal day[72].

There are existing roads to all three sites but no local traffic volume data is available. It has, therefore, only been possible to make a subjective comparison of the probably noise impacts at the three sites.

(vi) 69 KV Transmission Line

The only significant noise that will arise from the operation of the 69 KV transmission line will be from the transformers at the various substations in the system. The noise levels to be expected from these transformers, some of which have not been specified precisely yet, have been obtained from B.C. Hydro[73] and a recently developed transformer noise propagation model was used[74].

A. Mine Substation

The two transformers to be used, at least initially, at the mine substation will be used 66 kv/12.6 kv units with a rating of 20 MVA. No accurate noise levels are available for them but B.C. Hydro suggested that a conservative rating would be 75 dBA*.

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* B.C. Hydro generally requests that transformers for noise sensitive areas be about 6 DBA quieter than the NEMA rating for a particular unit. Thus a NEMA rating of 81 dBA would correspond to a B.C. Hydro rating of 75 dBA.

B. Plant Construction Substation

It is likely that the 66 KV/12.6 KV transformers specified above for the mine substation will be moved to the plant construction substation when they have become insufficient for the needs of the mine.

C. Rattlesnake Substation

This substation, which will contain two 230 KV/69 KV transformers, will be located at one of two sites north-east of Cache Creek as a general-purpose extension of B.C. Hydro's distribution system in the area. The exact rating of the transformers is not known but 150 MVA each is felt by B.C. Hydro to be a conservative figure. B.C. Hydro's noise level rating for such a unit is 78 dBA.

D. Booster Pumping Station Transformers

The two make-up water pumping stations will each have a 20 MVA, 69 KV/ 4.16 KV transformer for which B.C. Hydro's noise rating is 67 dBA. However, the noise from these units has been treated as part of the total noise from the pumping stations and will be addressed in the "make-up cooling water supply system" portion of Section 6.4 b.

(d) Traffic Noise from Existing Highways

Many people in the study area live close to an existing highway. In general, their present YDNL's are controlled by traffic noise from these highways and in many cases will still be controlled by traffic noise after the project begins. Therefore, it is important to estimate, as accurately as possible, the increase in traffic noise levels that will occur as a result of the project.

(i) Highway 12

Future daily traffic volumes on Highway 12 with and without the project were provided by Strong Hall & Associates[75]. Existing (1976) traffic volumes were obtained on a seasonal basis from Strong Hall (Summer - 400/day) and from traffic counts during noise monitoring (winter - 150/day, Fall - 300/day, Spring — assumed same as Fall). This data was recorded near Pavilion and near the Hat Creek junction respectively.

The future daily traffic volumes without the project for Winter, Spring and Fall were assumed to bear the same relationships to the Summer volumes (supplied by Strong Hall) as presently exist, that is, Winter (37.5%) and Spring and Fall (75%). The percentages of trucks in the traffic were conservatively maintained at the existing levels which are quite high due to the use of the highway by ore trucks. The existing truck percentages were obtained during baseline noise monitoring at Sites 1 and 2. (See Table 3-3 herein.)

The ratio of future daytime to nighttime traffic without the project was assumed to stay the same as was determined during the 1976 baseline noise monitoring. The day-night division of project-associated traffic was given by Strong Hall.

Increases in future Highway 12 traffic noise levels (L_{dn}) due to the project were computed from the predicted traffic volume increases for each season. These seasonal increases were then logarithmically averaged to give the increase in YDNL due to the project traffic in various future years.

(ii) Highways 1 and 97

The 1976 Summer traffic volumes on Highway 1 at the China Bar Tunnel and on Highway 97 north of the Carquille junction were 8522/day and 6000/day respectively[76]. The additional traffic associated with the project (peak volume on all roads about 700/day) will cause no perceptible increase in the YDNL's experienced by residents near these major highways.

4.4 PROJECT DECOMMISSIONING

(a) Mine Reclamation

The two major activities associated with the reclamation of the mine are:

1. recontouring the pit slopes and flooding the pit.
2. restoring dumps to be suitable for grazing or forestry.

Subjective appraisals of the degree of noise impact of these activities have been made through the comparison of their scales with those of mining activities. More precise estimates cannot be made at this time.

(i) Pit Reclamation

The preferred plan for pit reclamation is to allow it to fill up with water and become a lake. It would take roughly 26 years to fill up. Immediately following the end of mining the pit walls would be recontoured for reasons of stability, drainage and appearance[77]. No details of equipment to be used or schedules are available, however, B.C. Hydro expects to finish all their reclamation work within 10 years of the end of mining.

Through a comparison of the total volume of material to be moved per year during mine production with that to be moved during pit recontouring (assuming it takes 3 to 5 years to complete), it is seen that the level of activity during reclamation will be only 2 to 4% of that during mining. This corresponds roughly to a 14 to 17 dB reduction in pit noise assuming similar equipment is used. In addition, there will be little activity at ground level to correspond to the removal of superficials during mining and both blasting and coal preparation noises will be absent. Therefore, it is loosely estimated that the pit reclamation process will generate YDNL's that are 20 dB lower at critical receptor locations than will the mining activity. Combining this with the much shorter duration of the reclamation activity (5 years vs. 35 years for mining) it is concluded that the overall noise impact of the pit reclamation work will be insignificant compared to the noise from the mining activity that will preceed it.

(ii) Waste Dump Reclamation

This work lis workncludes recontouring and covering with topsoil, will begin as soon as a dump has reached the top of its main embankment. For the Houth Meadow dump this will be in about 2005 and for the Medicine Creek dump, it will be a few years later.

It is expected that all dump reclamation will be completed by the time mining stops. Therefore, the noise generated by dump reclamation will not be significant compared to noise still being generated by mining, blasting and the coal preparation facilities.

(b) Plant Decommissioning

No detailed information is available on the methods and equipment to be used nor the schedule to be followed during plant decommissioning and demolition. Therefore, it can only be estimated that the noise created by plant demolition will be comparable to that created by its construction. This is no doubt conservative since the site preparation and excavation requiring much heavy equipment will not be duplicated and the process will certainly take much less time than construction. Finally, because of the 35 years of plant operation noise to which the local receptors will have been exposed, the beginning of decommissioning of the plant will represent a substantial reduction in their plant noise exposure and hence will not likely be considered as a significant additional noise impact. A more detailed discussion of plant and off-sites decommissioning noise impact can be found in Section 6.6.

4.5 PRECONSTRUCTION ACTIVITIES

Noise-producing activities have been carried out in the Hat Creek Valley for some time as part of a program to evaluate the coal deposits. These are the bulk sample and the exploratory drilling programs.

(a) Bulk Sample Program

(i). Predicted Noise Levels

Prior to the start of the bulk coal sample program, the noise levels to be produced by its major activities were predicted. The results were presented in a May 20, 1977 report entitled "Preliminary Noise Impact Assessment of Hat Creek Bulk Sample Program".

The major activities were excavation of the two trenches, A and B, and the trucking of the coal over Highways 12 and 97 to Ashcroft. (See Figure 4-3).

Noise levels from trench excavation were estimated at the south-west corner of Bonaparte Reserve 1 and at the nearest Hat Creek Valley ranch house (Ed Lehman). These were respectively L_{dn} 37 and 49 from Trench A operations and L_{dn} 42 and 46 from Trench B. In arriving at these levels, no wind attenuation or topographic shielding were assumed.

The hauling of coal over Highway 12 was to average sixteen 25-ton truck loads per day, giving, therefore, 32 truck events per day. All trucking was assumed to be done in the daytime and all trucks to be fitted with standard mufflers.

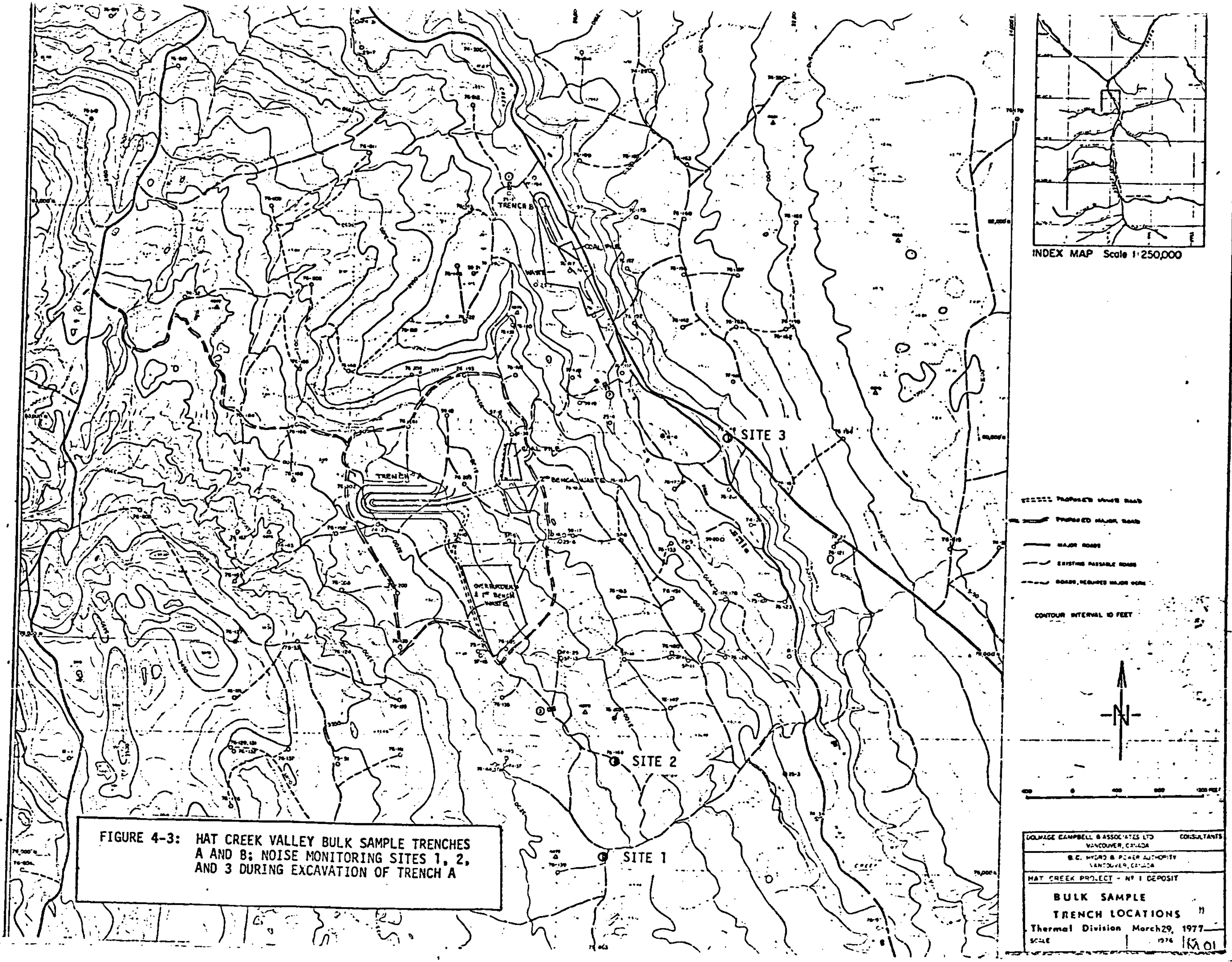

FIGURE 4-3: HAT CREEK VALLEY BULK SAMPLE TRENCHES A AND B; NOISE MONITORING SITES 1, 2, AND 3 DURING EXCAVATION OF TRENCH A

The predicted increase in L_{dn} along Highway 12 due to the coal hauling was only 1 dB on weekdays and slightly larger on weekends. On Highway 97, the coal hauling would have a negligible effect.

(ii) Measured Noise Levels

During the excavation of Trench A, 1/2 hour continuous noise measurements were made at three sites in the Hat Creek Valley. The sites are shown in Figure 4-3. The results of these measurements were presented in a June 8, 1977 report entitled "Noise Levels Generated by the Hat Creek Bulk Sample Program, Trench A". The measured values of L_{eq} (1/2 hour) at Sites 1, 2 and 3 respectively were 33, 38 and 49 dB. At Sites 1 and 2, the intervening terrain provided substantial noise shielding. From Site 3, on the east slope of the valley, there was a direct line of site to the trench. For purposes of comparison, the Trench A noise level was then predicted at Site 3 using the weather conditions existing and numbers and types of equipment operating at the time of the measurements at that site. The predicted level was L_{eq} 53 which is 4 dB higher than the measured level.

Brief measurements of Trench A noise were also made near the southwest corner of Reserve 1 and at the Ed Lehman ranch. At the former location, the trench operations were inaudible above the 35 to 40 dBA background noise of wind in trees and running water. At the Lehman ranch, the background noise level from wind and water varied from 40 to 44 dBA and the trench operations were only intermittently audible above this natural noise. By comparison, the predicted noise levels were L_{eq} 41 (L_{dn} 37) at Reserve 1 and L_{eq} 53 (L_{dn} 49) at the Lehman ranch. Again, the predicted levels are higher than those observed here, by from 6 to 11 dBA at Reserve 1 and from 9 to 13 dBA at the Lehman ranch. The discrepancies are believed to be largely due to local topographical shielding.

No measurements were made of coal trucking or Trench 8 excavation noise levels.

(b) Exploratory Drilling Program

Exploratory drilling to establish the extent and quality of the Hat Creek coal deposits have been carried out sporadically for more than 50 years, however, the intensive drilling program associated with the present thermal power project was started by B.C. Hydro in 1974. This program reached its peak from September 1977 to January 1978 when a total of nine drilling rigs (five diamond drills, one large rotary rig, one bucket auger and two Becker hammer drills) were in use throughout the valley[77a]. Noise levels created by such equipment can range approximately from 80 to 100 dBA at 15 m (50 ft.) depending on the type of rig and the composition of the ground being drilled. In the Hat Creek Valley, where ambient noise levels are typically less than 40 dBA, such drilling operations will have been audible over distances of from 0.8 to 3.2 km (0.5 to 2.0 miles) under the worst case conditions of no wind attenuation and no significant topographical shielding. However, in many situations, the Hat Creek Valley ranch houses will have received some additional noise shielding from the high banks of the creek and the uneven valley walls. Nonetheless, the drilling operations at times will have been a source of annoyance to the valley residents.

During 1978, two or three drilling rigs will be working to fill in gaps in the 152 m (500 ft.) on-centres grid.

Throughout the operation of the mine, one or two drilling rigs will be used to provide coal samples on a 60 m (200 ft.) grid prior to excavation in order to allow the coal quality to be controlled. These rigs will typically drill holes only 9 m (30 ft.) deep so that they will usually be operating within the pit itself. The noise from an operation of this scale, where the drilled material will typically be soft coal, claystones or siltstones, will not contribute significantly to the total operation noise of the mine and hence will not be discussed further in this report.

5.0 NOISE IMPACT ASSESSMENT METHODOLOGY

5.1 ENVIRONMENTAL IMPACT IN THE GENERAL CONTEXT

(a) Changes in Resources

In the general context of the Hat Creek environmental noise studies, impact is defined as a change in a resource (as it presently exists or is expected to exist in the future) resulting directly or indirectly from project actions[78].

A resource is considered to be any aspect of the environment which has, or will in the future have, value to man because it provides revenue, recreation or aesthetic appeal or somehow adds to the quality of life. The resource changes which could possibly result from the intrusion of industrial noise are:

1. hearing loss and other severe health effects
2. degradation of the "best use" of land
3. degradation of the acoustic environment (annoyance)
4. displacement of and/or injury to wildlife.

(b) Assignment of Noise Impact Costs

Wherever possible, it is desirable to assign a monetary value to the impact (resource change) associated with intruding project noise so as to provide a common base for comparison with other project impacts and to assist in any compensation actions. With the exception of hearing loss (occupational noise exposure will not generally be a iressed herein), the only noise impacts to which monetary values an be attached with any accuracy are:

1. the necessary change in best land use brought about be the increase in noise levels on a property which either results in Hydro buying the property or paying the owner for his lost future revenue.
2. the necessary purchase of land by B.C. Hydro solely because of noise impact although the increased noise levels do not exceed the criteria for the best or present land use.

L nits have been set by various agencies (see section 5.2 b) for the nvironmental noise levels which are compatible with various land uses. ən a project action results in the excedence of one of these limits, the financial loss suffered through the use of the land at less than s highest capacity can be considered to be a cost to the project.

collaboration with Strong Hall & Associates, the consultants have e-tablished general guidelines by which the costs of such noise mpacts could be computed, both for the case in which B.C. Hydro buys ə property concerned and that in which they don't (the latter case applying primarily to Indian lands). These guidelines are contained Appendix D.

2 NOISE IMPACT CRITERIA

ıe impacts of noise on humans can be placed in three major categories depending on the noise levels encountered and the use to ıich the land is or will be put. These categories are: severe health effects, land use incompatibility and annoyance. Each ıtegory and its appropirate noise level criteria will be discussed ubsequently but first the criteria-selection process is described.

Applicable Canadian noise control regulations and guidelines were reviewed with the following results :

1. At the municipal government level, the Hat Creek Valley is an unincorporated area and hence has no noise regulations. The Village of Ashcroft, however, adopted an "Anti-Noise By-Law No. 280, 1977". This is a noise "nuisance" by-law which prohibits the production of "objectionable" or "disturbing" noises and limits construction activities to between 7.00 a.m. and 9.00 p.m., except where the permission of the village clerk has been given. Other British Columbia cities and municipalities such as Vancouver (Noise Regulation By-Law) and Burnaby (Burnaby Noise or Sound Abatement By-Law 1971) have quantitative noise bylaws which specify maximum levels for specific types of machines (motor vehicles, lawn mowers, jackhammers etc.) and maximum property line noise levels for industrial operations in activity and quiet zones. For example, the Burnaby By-law states that daytime property line noise levels in residential and commercial-industrial districts shall not exceed 55 and 65 dBA respectively, whereas at night (10.00 p.m. to 7.00 a.m.) these limits are both reduced by 10dBA.

2. The British Columbia Provincial Government has not formulated any noise control regulations.

3. At the federal level, the Division of Applied Physics of the National Research Council (NRC), in 1968, issued a report entitled "A Brief Study of a Rational Approach to Legislative Control of Noise" which was intended to provide guidance to municipalities in the formulation of noise by-laws.
The Central Mortgage and Housing Commission (CMHC), in 1970, published guidelines for the control of noise impact on residential developments for which federal financing is sought. These were contained in their "Site Planning Handbook". In 1976, the CMHC, in collaboration with the NRC, prepared a supplement to the above handbook which dealt

exclusively with the impact of road and rail noise on new residential developments. This supplement was entitled "New Housing and Road and Rail Noise" and it is expected to come into force in 1978. In it, traffic noise level criteria were given which would result in the property involved being judged acceptable or unacceptable for residential land use. Inherent in these criteria is the assumption that the new housing boundaries can, within limits, be upgraded to provide acceptable indoor noise environments in areas where outdoor noise levels are higher than those considered normally acceptable.

Although the by-laws and guidelines described above are useful in coming to grips with the problems of noise in urban areas or areas near traffic arteries, they do not provide a broad enough base from which to assess the impact of a project such as that under study here. Many noise concerns unique to rural and unpopulated areas must be addressed here, so that regulations dealing with, for example, property line noise levels within urban residential areas, do not apply. Project noise impact must be evaluated for grazing and recreational land as well as residential.

For these reasons, the noise level criteria to be adopted for this study will be largely based on the recommendations of the U.S. Environmental Protection Agency's March 1974 publication entitled "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Marge of Safety", hereafter referred to as the "Levels Document". The Levels Document establishes environmental noise levels which are required to assure that the large majority of people are protected from hearing loss and other negative health and welfare effects with an adequate (5 dBA) margin of safety. It also provides a procedure for the assessment of probable community response to the annoyance of intruding noise in areas with various amounts of experience with and attitudes towards the intruding noise and with various existing (pre-intrusion) environmental noise levels.

Thus, the Levels Document offers a more widely applicable and flexible basis on which to establish noise level criteria for a large project, such as Hat Creek, which involves both. rural and town situations and a large variety of noise sources, than do any existing Canadian guidelines or regulations.

The maximum acceptable residential noise level proposed by CMHC is slightly less stingent than the corresponding criteria from the Levels Document. The scale of community annoyance to intruding noise developed in the Levels Document resulted from an empirical attempt to quantify the concerns with public annoyance due to noise which are inherent in noise nuisance by-laws such as that in force in Ashcroft. Hence, the Levels Document incorporates all the pertinent aspects of existing local and federal regulations which are applicable to the study area and, in addition, covers many areas of noise impact not covered by Canadian Regulations.

The various noise level criteria used in this study are summarized in Table 5-1 and will be described in the following sections.

It is recognized that many of the effects that noise has on humans are also evident in animals. However, few acceptable noise level criteria have been established for animals so that the only quantitative animal noise exposure used herein is for livestock (cattle grazing). A general description of the effects of noise on animals is given herein, but the assessment of the impact of project noise on particular groups of Hat Creek wildlife has been carried out by Tera Consultants in their Appendix A3.

	JURISDICTION OF NOISE LEVEL CRITERION	NOISE LEVEL CRITERION	COMMENTS	REFERENCE
1.	Severe Health Effects in Humans	L_{eq}(24) 70	To protect against hearing loss and various stress-related diseases over a working lifetime.	U.S. EPA Levels Document (Ref. 79)
2.	Residential Land-Use Incompatibility	YDNL 55	To protect against negative effects on public health and welfare: interference with activities, e.g. speech communication and sleep.	U.S. EPA Levels Document (Ref. 79)
3.	Annoyance and Public Reaction Thresholds	YDNL of Intruding noise 10 dB below existing YDNL, or normalized YDNL of Intruding Noise 5 dB below Existing YDNL.	No public reaction if meet either criterion. If don't, public reaction increases with normalized YDNL.	U.S. EPA Levels Document (Ref. 79)
4.	Grazing Land-Use Incompatibility	YDNL 65	To provide suitable environment for stock raising.	U.S. F.A.A. Airport Noise Evaluation Procedure (Ref. 82)
5.	Agricultural Land-Use Incompatibility	L_{eq}(24) 70	As in 1.	U.S. EPA Levels Document (Ref. 79)
6.	Unpopulated Areas (Recreation)	Natural Sound Levels (YDNL 30 to 40)	No single criterion available, but any identifiable noise intrusion considered environmental degradation	U.S. EPA Levels Document (Ref. 79)
7.	Very Infrequent Intermittent Noises (Nighttime) 5 to 30 sec. duration	With-Project YDNL plus 20 dBA to maximum of 75 dBA	Outdoor, A-weighted level; Threshold of significant sleep disturbance	Vancouver International Airport Noise Study (Ref. 85)

TABLE 5-1: SUMMARY OF NOISE LEVEL CRITERIA

	JURISDICTION OF NOISE LEVEL CRITERION	NOISE LEVEL CRITERION	COMMENTS	REFERENCE
8.	Public Address and Signal Systems (Frequent use)	Essentual Inaudibility above background noise of continuous project activities	Outdoors at nearest residence, present or future (See Section 5.2 e)	
9.	Impulsive noise (Blasting and Circuit Breakers)	140 dB peak Linear	Outdoors at project property Line or nearest unprotected receptor on site.	Worker's Compensation Board of British Columbia January 1, 1978 Regulations.

TABLE 5-1: SUMMARY OF NOISE LEVEL CRITERIA (Cont'd.)

(a) Severe Health Effects in Humans

Loss of hearing acuity and various non-auditory, stress-related diseases in humans may result from exposure to noise levels exceeding $L_{eq}(24)$ 70 over a period of many years[79]. The appropriate noise level descriptor is in this case $L_{eq}(24)$ rather than L_{dn} since human susceptibility to these severe health effects does not show a daytime to nighttime variation. Since the concern here is with environmental and not occupational noise exposure and since the large proportion of environmental noise exposure is received while indoors, the outdoor noise levels required for the onset of these effects would be $L_{eq}(24)$ 75 to 85. This is based on the typical house providing a sound attenuation of 15 dBA. There are not at present nor are there likely to be in the future any human residences situated in areas that will be exposed to project noise levels in or near this range. Therefore, this form of noise impact will not be considered further.

(b) Incompatibility with Best Land Use

The second category of the impact of noise on humans can be described in terms of the rendering of land unsuitable for its best use. In general, the present land use will be considered to be the best land use; possible exceptions include the potential future conversion of grazing or agricultural land to residential or passive recreational land.

(i) Residential Land Use Incompatibility

On present or probable future residential land, the primary concern is that noise does not have negative effects on public health and welfare. The negative effects of noise which can result in residential land-use incompatibility are mainly due to:

1. interference with human activities, predominantly speech communication and sleep,
2. creation of annoyance.

Criteria for the first type of impact, interference with activities, can be quite accurately quantified. For example, it has been established that sentence intelligibility will be perfect indoors and only slightly diminished outdoors (with a 5 dB safety margin) when the outdoor noise level is YDNL 55[80]. This level of environmental noise is considered to be the maximum level below which no effects on public health and welfare occur due to interference with speech or other activities for the most sensitive portion of the population.

This same level of oudoor noise, YDNL 55, is felt to provide an acceptable interior noise level for sleeping in a typical residential community where nighttime environmental noise levels are generally lower than those of the day[81]. This situation will exist for project construction activities which will all be restricted to the daytime. Most project operating noise will not be reduced significantly at night but will be quite continuous and uniform in nature. Therefore, provided that those intermittent project noises which can't be restricted to the daytime are restricted to acceptable levels (see Section 5.2 d), the achievement of YDNL 55 outdoors will assure an acceptable sleeping environment indoors.

The U.S. EPA has also concluded that, in the absence of intrusive noise with adverse frequency content, the achievement of YDNL 55 will protect against severe annoyance (which could result in the land being judged incompatible) under most conditions. Annoyance, however, is a very personalized reaction and will be discussed further in Section 5.2 c.

(ii) Grazing Lands

The need to forecast aircraft noise impact around major airports has led to the development of maximum noise level criteria for various land uses[82]. These criteria are summarized in Table 5-2. The appropriate criteria for cattle grazing (the predominant occupation in the Hat Creek Valley region) would be that of livestock farming with a maximum compatible noise level of YDNL 65 and a marginally compatible range from YDNL 65 to 75. The noise around the proposed plant and mine would be much more continuous and predictable than that around an airport and, therefore, will be less disturbing to cattle. It is, therefore, conservative to assume that cattle grazing can be carried out compatibly on land with noise levels of YDNL 65 or lower*.

(iii) Agricultural Lands

Since purely agricultural land is generally uninhabited by humans or animals, the acceptable noise levels are higher but they must be limited to the allowable occupational noise exposure of the farm workers. The criteria adopted for farm lands is, therefore, that which will adequately protect against hearing loss in a normal lifetime, i.e. $L_{eq}(24)$ 70.

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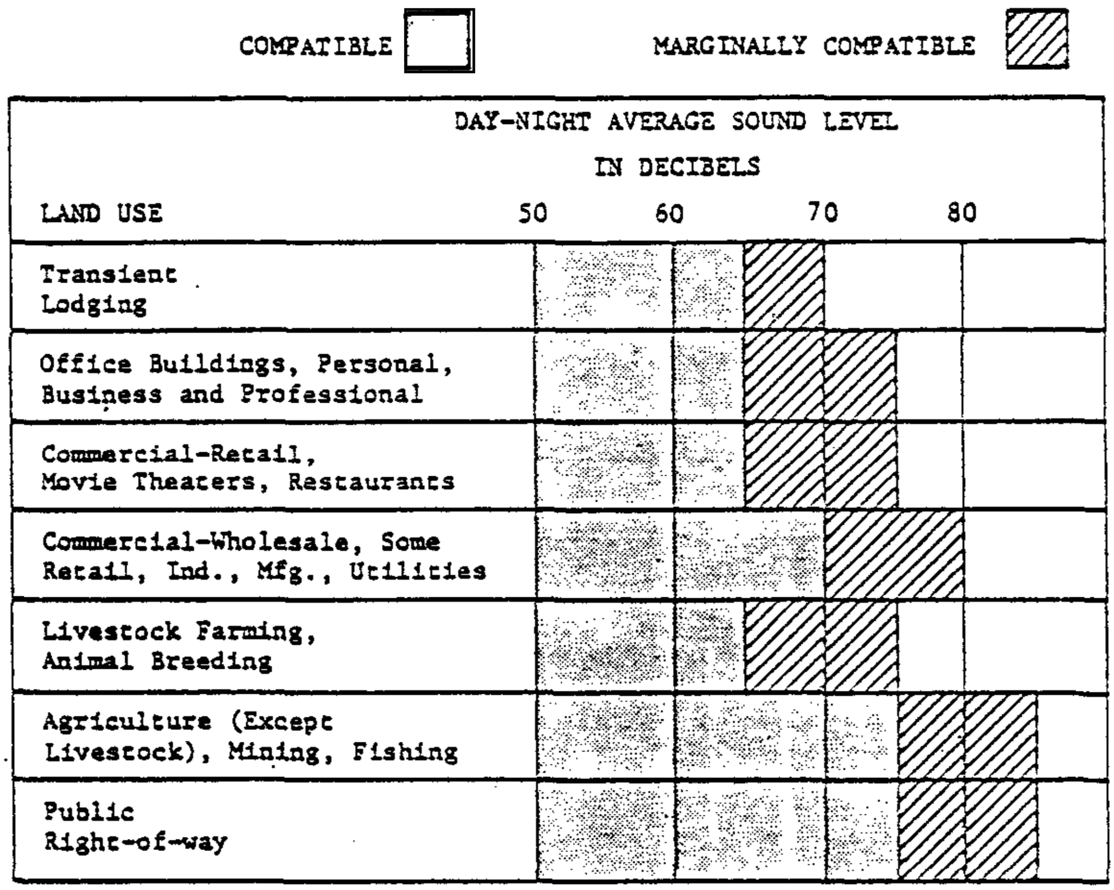
* This criteria was selected over that given in the Levels Document [$L_{eq}(24)$ 70 dB for farm and general unpopulated land] since the former is more specific as to land use and slightly more stringent.



Source: Adapted by R. W. Young from Figure 2-15 of HUD Report TE/NA-472 November 1972 "Aircraft Noise Impact: Planning Guidelines for Local Agencies" by Wilsey & Ham and Bolt Beranek and Newman.

TABLE 5-2: LAND USE COMPATIBILITY WITH DAY-NIGHT AVERAGE SOUND LEVEL (YDNL or L_{dn}) FOR BUILDINGS AS COMMONLY CONSTRUCTED.

(iv) Unpopulated Areas

Unpopulated areas include wilderness areas and parks that provide for the enjoyment of the natural environment. Although quiet is not of paramount importance for all human activities carried out in such areas, many people value the tranquility of natural areas and the quiet that allows natural sounds to be heard. It is not possible at this time to identify an appropriate noise level to prevent annoyance and interference with such recreational activities as hiking, riding and camping. Therefore, it must suffice to acknowledge that any identifiable intrusion of man-made noise into such areas will constitute a degradation of the natural environment and hence an impact. The degree of impact will increase as the level of intruding noise increases relative to the natural sound levels which typically range from YDNL 30 to 40 depending on average wind speed, vegetation and proximity of water bodies, etc.

(v) Multi-Land Use Areas

Where a land area exposed to quite uniform levels of project noise encompasses more than one land use, such as intermixed agricultural and grazing lands, the noise level criteria applied to the area will be that of the most noise-sensitive land use.

(c) Annoyance and Community Reaction to Project YDNL's

When an intruding noise causes a detectable increase in the environmental noise level in a residential area but does not cause it to exceed YDNL 55, environmental degradation is said to occur. The area remains compatible with residential land use and the judgement of the impact of the noise increase must be made in terms of annoyance and community reaction. This is the third major type of noise impact on humans.

It is not possible to set a rigid limit on intruding noise levels below which there will be no annoyance expressed by the exposed population and no negative community reaction. This is because annoyance due to noise can vary widely from person to person and even from community to community. Community reaction to an intruding noise can be influenced by: nature and duration of noise, previous noise exposure, age, socio-economic status, political cohesiveness and relationship with the noise producer. Many of these factors cannot be evaluated quantitatively but must be given some qualitative consideration. Other factors, such as level of community activity and previous noise exposure, have been quantified and used to improve the correlation between levels of intruding noise and community reaction to them[83]. These "corrections" were initially developed on an intuitive basis but have since been modified and substantiated in a study of 55 different noise impacts situations and are now recommended by the U.S. EPA for use in the adjustment of intruding noise levels to account for community sensitivity in the prediction of annoyance. The corrections are given in Table 5-3. They occur in 5 dB intervals because it is considered difficult to assess community reaction to any greater degree of accuracy[84].

The corrections of Table 5-3 are used herein to account for the sensitivities of residential areas to project noise. The noise levels thus corrected are referred to as "normalized YDNL's".

The threshold of noise impact due to annoyance is established as follows. No community reaction is expected, and no noise impact is assumed to occur, if the normalized YDNL of an identifiable intruding project noise is approximately 5 dB less than the YDNL that exists in the absence of that intruding noise. That the intruding noise be identifiable is important, since if the noise is not identifiable, then there is no need to consider

Type of Correction	Description	Amount of Correction to Be Added to Project YDNL or L_{dn} in dB
Seasonal Correction	Summer (or year-round operation).	0
	Winter only (or windows always closed).	-5
Correction for Outdoor Residual Noise	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking).	+10
	Normal suburban community (not located near industrial activity).	+5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas).	0
	Noisy urban residential community (near relatively busy roads or industrial areas).	-5
	Very noisy urban residential community.	-10
Correction for Previous Exposure and Community Attitudes	No prior experience with the intruding noise	+5
	Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good.	-5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	-10
Pure Tone or Impulse	No pure tone or impulsive character.	0
	Pure tone or impulsive character present.	+5

TABLE 5-3: COMMUNITY SENSITIVITY CORRECTIONS TO BE ADDED TO YDNL OF INTRUDING PROJECT NOISE TO OBTAIN NORMALIZED YDNL (ORIGINAL SOURCE — REFERENCE 79).

the community sensitivity to it. For the purpose of this study, an intruding noise is considered to be identifiable if its actual YDNL is fewer than 10 dB below the existing YDNL without the intruding noise.

There are then two criteria by which an intruding noise can be judged to cause no annoyance to the community:

1. the actual YDNL of the intruding noise is 10 dB or more below the existing YDNL.
2. the normalized YDNL of the intruding noise is 5 dB or more below the existing YDNL.

Intruding noise which meets neither of the above criteria will have the potential to cause annoyance and the degree of annoyance will increase with its normalized YDNL.

The normalized YDNL of the intruding noise can be used to predict the expected annoyance as expressed by the level of community reaction to the noise; again based on the results of the survey of 55 noise impact situations. Figure 5-1 shows the levels of community reaction and annoyance expected to result from given levels of normalized YDNL for intruding noises.

(d) Annoyance Due to Intermittent Noises

As was stated in Section 4.1 b (ii), compliance with average noise level criteria, such as normalized YDNL, is not sufficient to assure the absence of impact due to annoyance. Infrequent, intermittent noise events may be very disturbing (especially at night) without being very significant to YDNL if their levels rise substantially above the normal background noise level.

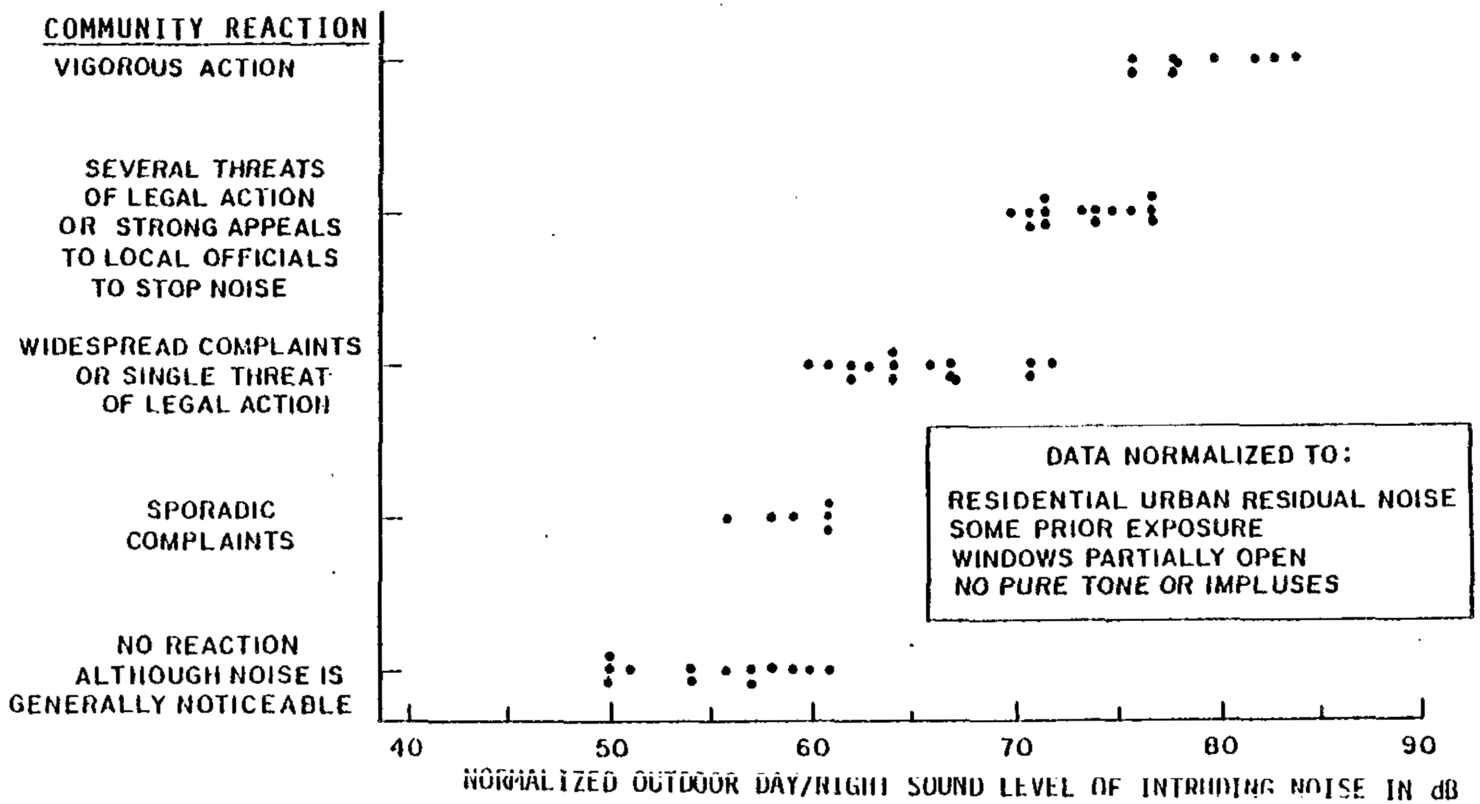


Figure 5-1: Community Reaction to Intensive Noises of Many Types as a Function of the Normalized Outdoor Day Night Sound Level of the Intruding Noise
(Source: Reference 79)

Such noises may interfere with speech communication, disturb sleep (either by causing waking or a shift towards lighter sleep levels) or just cause general annoyance. For the purpose of setting a criterionfor such intermittent noise levels, the typical threshold of sleep disturbance will be used as this is felt to be the most significant type of impact from such noises.

Intermittent plant noise sources which are of concern because they may be active during evening and nighttime hours are: plant electromatic valves, circuit breakers and warning and shift signals and public address system at the plant and mine. Most of these noises will occur irregularly and infrequently (0-3 times per night) and will have durations in the 5 to 30 s range. (The public address systems, however, will likely operate much more frequently and hence will be treated separately below.) It was, therefore, felt appropriate to draw the intermittent noise level criterion from the concensus of a recent literature survey conducted into the effects of jet aircraft flyovers on sleep disturbance since aircraft flyover noise events typically have similar durations (time between 10 dB down points). The aircraft noise study concluded that an outdoor peak noise level of 75 dBA (60 dBA indoors with windows partly open) was a reasonable threshold of significant sleep disturbance for single noise events[85]. However, this threshold was established for urban and suburban residential areas around a major airport. Therefore, in keeping with the policy of noise criterion-correction for community sensitivity described in Section 5.2 c, the intermittent noise level criteria adopted herein will be adjusted to account for the quasi-continuous background noise level which will exist with the project.

In typical urban and suburban areas with no well defined noise source other than transportation noise, outdoor noise levels are in the YDNL 50 to 60 range[86]; YDNL 55 will be taken as the mean. The aircraft noise event criterion of 75 dBA is then 20 dBA above the typical existing YDNL. This relationship has been extended to the intermittent plant and mine noises and the resulting criterion is :

1. where YDNL with project is 55 or less, no evening or nighttime (7:00 p.m. - 7:00 a.m.) intermittent noise level shall exceed that YDNL by more than 20 dBA.
2. where YDNL with project is greater than 55, no evening or nighttime intermittent noise level shall exceed 75 dBA.

(e) Public Address Systems

Plant and mine public address (P.A.) systems, because of their much more frequent use, present a unique intermittent noise problem. They will operate day and night and because their noise generally will contain information (i.e. speech) it will likely be more distracting and annoying than other intermittent project noises of similar level. Therefore, it is desirable that the peak noise levels from the P.A. system be essentially inaudible above the steady background noise established by mine operations. One exception to this criterion is the pre-blasting warning signal which should be audible well beyond the project boundaries. However, pit blasting will be a daytime activity only.

The most critical location for the control of P.A. noise is the southern boundary of Bonaparte Reserve 1. The steady project noise level at this location will be essentially the same during the peak mine construction and operation years (see Sections 6.2 a respectively) and will not vary significantly throughout the 35 year operating life of the mine. Therefore, by selecting a peak P.A. noise level criteria of 10 dB below the relatively steady background noise during mining stage 6 (in all octave bands from 31.5 and 8000 Hz), significant annoyance due to the P.A. and warning systems will be avoided throughout the life of the mine. On this basis, the criterion for the mine P.A. and signal systems at the southern edge of Bonaparte Reserve 1 is as follows:

OCTAVE BAND CENTRE FREQUENCY (Hz)

31.5	63	125	250	500	1K	2K	4K	8K
55	51	48	46	44	34	23	20	20

MAXIMUM ACCEPTABLE PEAK SOUND PRESSURE LEVELS
(re: 20 μPa)

(f) Impulsive Noise Sources

The significant sources of impulsive project noise are blasting and circuit breaker operation. The contributions of mine pit blasting and plant circuit breaker operation have been accounted in computing the overall project YDNL. However, a separate criteria is required to assure that the noise levels created by individual impulsive noise events do not create a hazard to the hearing of neighbouring residents. For this criteria, the Worker's Compensation Board of B.C. regulations have been consulted. The January 1, 1978 regulations state that the maximum peak impulsive sound pressure level to which a worker may be exposed (even for only a few events per day) without his wearing a hearing protection device is 140 dB. This value has, therefore, been selected as the maximum permissible project impulsive noise level at the project property line for cases of only a few (less than ten) events per day.

(g) Noise Impact on Wildlife

Noise produces the same general types of effects on animals as it does on humans, namely: hearing loss, masking of communication and behavioural and non-auditory physiological effects[87]. The most observable effects seem to be behavioural. Noise of sufficient intensity or of a disturbing nature can disrupt the normal behaviour patterns of animals and may limit movement and, therefore access to food or shelter. Breeding habits can be disrupted.

The degree to which the activities of animals are effected by noise depends very strongly on the nature of the noise. If the noise is reasonably steady and predictable cattle and most large wild animals such as deer, antelope and sheep appear to quite quickly adapt to even quite high noise levels and go about their normal business along the borders of the noise source region. Antelope, adapted to living near a heliport in Texas, have been observed to go on feeding with a helicopter hovering about 23 m. (75 ft.) overhead[88].

Intermittent, unfamiliar noises, however, can be very disturbing to animals, and particularly in cold weather, can cause panic and flight which may tax severely an animal's energy reserves and may lead to bronchial problems and even death[89]. The most probable sources of such disturbing noises are low-flying aircraft, snowmobiles and other all-terrain vehicles plus plant steam-vents and circuit breakers and possibly warning signals from the plant and mine. At present the experimental evidence on which to base noise level criteria for hearing loss and lower-level chronic noise exposure of animals is incomplete and the conventional wisdom is to assume that animals will be at least partially protected by the application of maximum levels identified for human exposure[90].

(h) Blasting Vibration

In Appendix E, a scale is presented of the observed community response to blasting vibration versus the peak particle velocity of ground vibration measured in the ground near the residences in question. The peak particle velocity identified as resulting in the onset of community complaints is 0.254 cm/sec. (0.1 in/sec.) This level of ground vibration has, therefore, been adopted as the criterion for all project blasting activities and should be applied at the nearest occupied dwelling.

5.3 THE SPATIAL VARIATION OF NOISE IMPACT

The usual method of representing the spatial variation of noise level about a noise source is to plot contours through points of equal noise level. Such contours are an effective means of visualization, however, in the context of the present study, they have certain drawbacks:

1. Over flat terrain and relatively short distances, noise levels, and hence contour locations, can be calculated with reasonable accuracy and modest effort. However, in the case of Hat Creek, sound will be audible after traversing large distances over very uneven terrain. The accurate prediction of noise levels in each direction and at each distance from the various sources requires the unique calculation of the effects of topography.
2. The positions of noise level contours are greatly affected by seemingly minor changes in noise source level. Thus, a noise level contour plot conveys a somewhat exaggerated impression of precision and finality.

For these reasons, and also because of the widespread and discrete nature of the significant noise receptors in the Hat Creek region, noise levels contours have not been accurately calculated throughout the area affected by project noise. Rather noise levels have been predicted at the discrete locations of significant receptors or receptor regions. Variations of noise levels throughout receptor regions have been evaluated and the fluctuation of these levels with project conditions and working assumptions have been noted.

5.4 TEMPORAL EFFECTS ON NOISE IMPACT

(a) The Variation of Project Noise Levels with Time

The noise levels created by the major project activities, particularly construction activities, will vary from minute to minute and from year to year. The short-term variations are accounted for by the concept of usage factor (see Section 4.1e) and are incorporated in the YDNL's predicted for the various activities. The long-term variation of YDNL as the project proceeds will be quite minor once construction is complete and full scale production is underway.

It is considered that the temporal variation of the noise impact of the project can be adequately indicated if that impact is determined at the following three points during the project history[31]:

1. the first year of the project,
2. the worst year of the project (highest impact),
3. the last year of the project.

Separate impact analyses are required for each of these three years only if the variations in impact level among them are significant. That is, if the variations in noise levels or in exposed populations are large compared to the accuracy with which noise impact and receptor response can be predicted.

(b) The Effect of Activity Duration on Noise Impact

The duration of a noise-producing activity is usually given consideration in establishing acceptable noise level limits for the activity. For activities lasting less than one year, a duration correction is inherent in the calculation of the YDNL for the activity. For example, the YDNL of a 6 month activity is 3 dB less than that of an equivalent 12 month activity.

The Levels Document criteria are intended to protect the public health and welfare from long-term noise exposure; in the limit this means a working lifetime. The Levels Document does not specify criteria for short-term noise exposure such as that from a construction project. Hence, it is conservative to apply the Levels Document criteria for health and welfare effects, i.e. YDNL 55 for residential areas, to construction noise. In the prediction of normalized project YDNL and the resulting community reaction, however, the Levels Document does make allowance for activity duration. From Tables 5-3, it is seen that a -10 dB sensitivity correction is to be applied when the community knows that the noise is necessary and it will not continue indefinitely. In private communication , a U.S. EPA representative[91a] stated that this correction could not be applied in full to ordinary construction work but that some correction should be made, its value being based on the attitudes of the community towards the project.

In a 1977 publication by the U.S. National Academy of Sciences entitled "Guidelines for Preparing Environmental Impact Statements on Noise", changes in the noise environment are divided into three categories according to their duration[91b]:

1. Short-term Temporary Changes; exist for less than 6 months.
2. Long-Term Temporary Changes; exist for more than 6 months but less than 10 years.
3. Permanent Changes; exists for more than 10 years.

These guidelines suggest that the short-term temporary change does not require the same degree of noise documentation and impact assessment as do changes of longer duration but they do not specify different noise level criteria for such activities.

For the purpose of this study, in which most construction activities (except for the plant itself) will exist at any one location for one year or less, the above considerations have been interpreted as follows:

1. In the determination of the severe health and health and welfare effects of noise, no consideration will be given to activity duration other than that inherent in the calculation of YDNL for activities lasting less than one year.
2. In the determination of normalized YDNL, a community sensitivity correction of -5 dB will be applied for short-term and long-term temporary changes in the noise environment. This correction will only be applied if the noisy period under consideration is followed by a comparable period of relative quiet e.g. offsite construction, not plant or mine construction.

6.0 PROJECT NOISE IMPACT

6.1 LOCATIONS AND CHARACTERISTICS OF NOISE RECEPTORS

(a) Residential Areas

There are six existing residential areas which will or may be exposed to project noise. In the foreseeable future, no new residential areas are likely to be located in project noise-exposed areas except for the plant and mine construction camps. The six existing residential areas are discussed below and their probable sensitivities to project noise are established.

(i) Bonaparte Indian Reserves 1 and 2

Bonaparte Indian Reserves 1 and 2 lie along Highway 12 between its junctions with the Hat Creek Road and Highway 97 (See Figure 6-1) and have approximate populations of 30 and 35 respectively[52]. Reserve 1 will be exposed to construction and operation noise from both the mine and the power plant and to increased traffic noise from Highway 12. The only significant project noise exposure to Reserve 2 will be from increased Highway 12 traffic.

Most of the residences on these Indian lands lie within about 150 m (500 ft.) of Highway 12 and hence are presently exposed to noise levels between YDNL 50 and 41 due to traffic (See Figure 6-2). Therefore, although the setting is a rural one, the existing environmental noise levels are well above those typical of the natural environment.

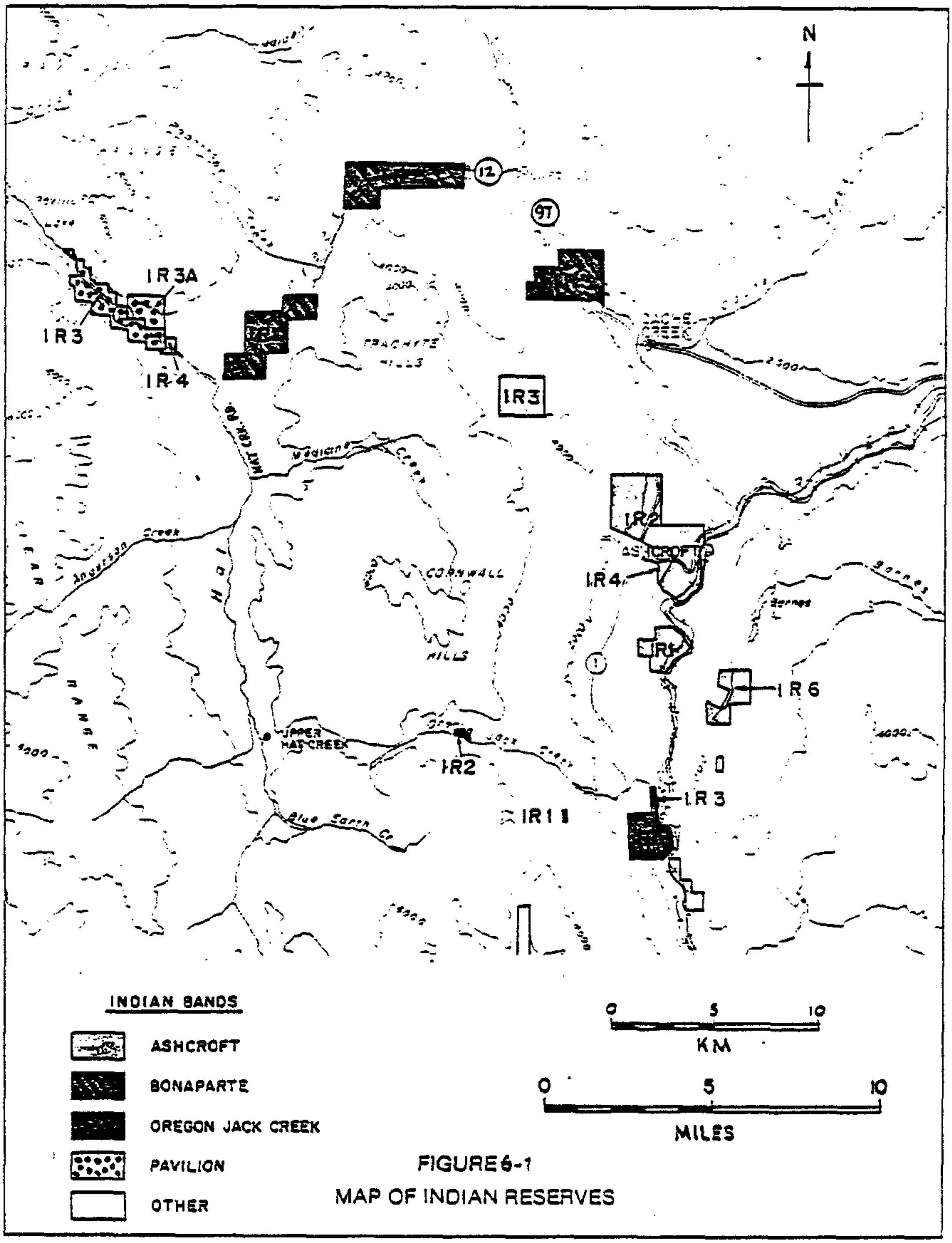


FIGURE 6-1
MAP OF INDIAN RESERVES

SOURCE: B.C. Research, Dolmage Campell & Associates Ltd.

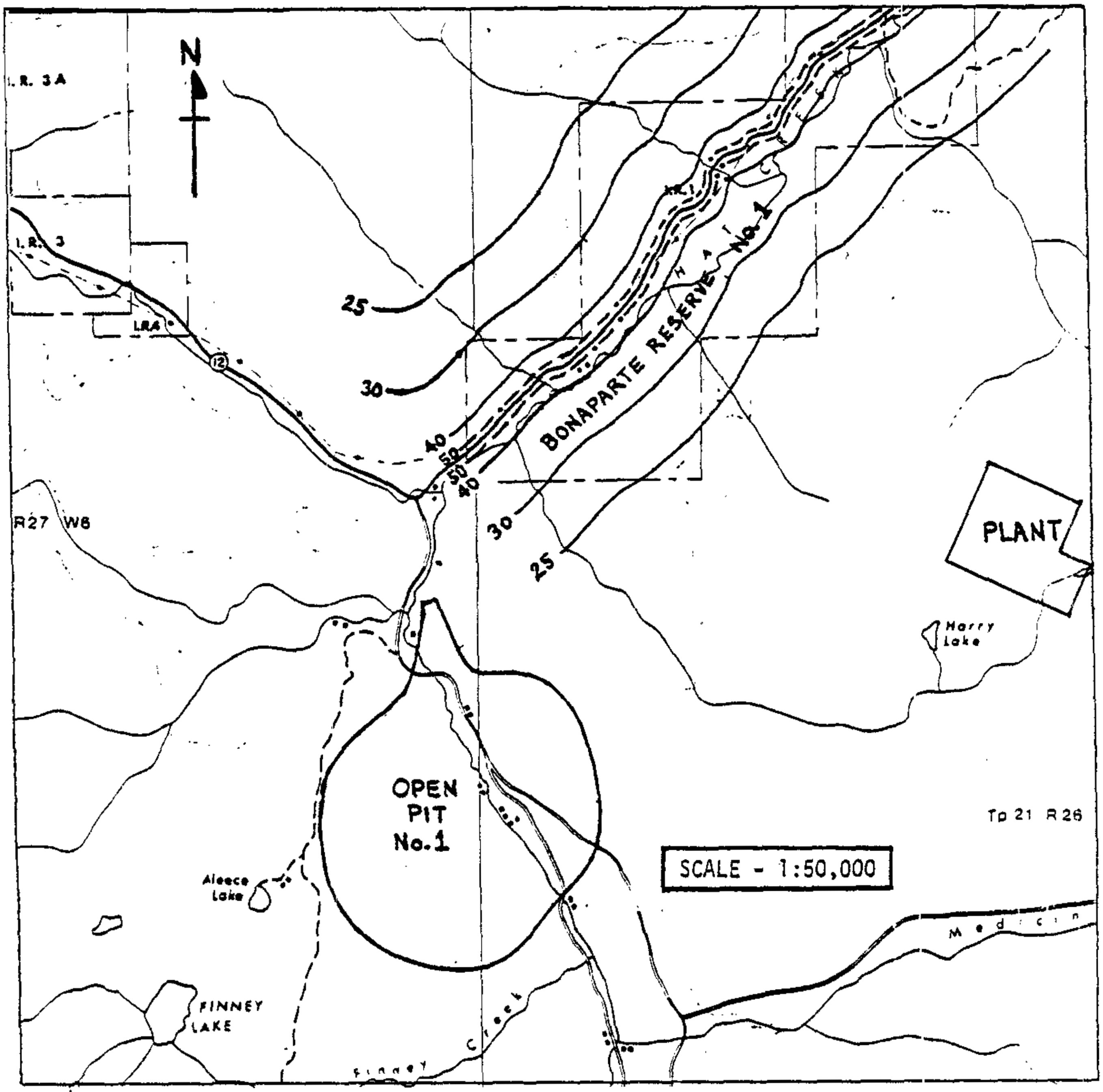


FIGURE 6-2: EXISTING (1976) HIGHWAY 12 TRAFFIC NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 DURING 1978-1979.

The appropriate corrections for community sensitivity to the intruding project noise are summarized in Table 6-1. These have been used to derive the normalized project YDNL's for the various receptor locations. The individual corrections for without project noise level, previous exposure and community attitudes and pure tone or impulsive noise content, were obtained from Table 5-3.

(ii) Upper Hat Creek Valley Ranch Houses

Those upper Hat Creek Valley ranch house residents who remain after the project begins will be exposed to plant and mine construction and operation noise. Most of the ranch houses still occupied lie along the old Hat Creek Road near the banks of the creek where the natural noise levels are relatively high due to the running water and, in summer, to the wind in the riverside deciduous trees. Therefore, the present noise levels at these sites likely somewhat exceed those observed at baseline monitoring sites 3 and 4 (L_{dn}'s from 32 to 41, see Table 3-2). Most man-made noise to which the residents are exposed is due to their own activity. These ranch houses, therefore, comprise a quiet rural community with no prior experience with industrial noise. As shown in Table 6-1, the total correction for community sensitivity is +15 dB for plant and mine construction and mine operation noise but is +20 dB for plant operation noise because of the likelihood that it will contain audible pure tones. As stated in Table 5-3, the sensitivity corrections at all residential locations could be decreased by 5 dB if the residents were given reason to believe that genuine noise control efforts were being made.

RESIDENTIAL AREA	PROJECT NOISE SOURCE(S)	SENSITIVITY CORRECTIONS FOR				TOTAL CORRECTION
		SEASONAL NOISE DURATION	OUTDOOR NOISE LEVEL W/OUT PROJ.	PREVIOUS EXPOSURE + COMMUNITY ATTITUDES	PURE TONE OR IMPULSE	
Bonaparte Reserve 1	Mine and Plant Construction and Mine Operation	0	+5	+5	0	+10
	Plant Operation	0	+5	+5	+5	+15
Upper Hat Creek Valley Ranch Houses	Mine & Plant Construction & Mine Operation	0	+10	+5	0	+15
	Plant Operation	0	+10	+5	+5	+20
Thompson -Bonaparte Confluence	River Bottom Preparation	0	0	-5 +5 = 0	0	0
	Water Intake Construction	0	0	-5 +5 = 0	+5	+5
	Pumping Station Construction	0	0	-5 +5 = 0	0	0
	Pumping Station Operation	0	0	+5	+5	+10
North Ashcroft Subdivision	Water Pipeline Construction	0	+5	-5 +5 = 0	0	+5
	Offloading Facility Operation (Trucking)	0	0 to +5	0	0	0 to +5
Along Highway 1 Western Semlin Valley	Airstrip Construction and Operation	0	-5	+5	0	0

TABLE 6-1: COMMUNITY NOISE SENSITIVITY CORRECTIONS (dB) FOR VARIOUS RESIDENTIAL AREAS. (See Table 5-3)

(iii) Thompson Bonaparte Confluence Area

There are presently eight homes (housing approximately 21 people) located along the northern village boundary of Ashcroft where the Bonaparte River flows into the Thompson. Most of these homes are located within 250 m (800 ft.) of the proposed sites of the make-up water intake and booster pumping station No. 1. These residents will, therefore, be exposed to the construction and operation noise of these two facilities plus the noise of local pipeline construction.

The existing noise levels in this area are already quite high due to the nearness of both the CNR and CPR mainlines (see Figure 2-2). A baseline noise level of L_{dn} 56 was measured in May 1977 at monitoring site 5 [about 300 m (1000 ft.) from the CNR line]. The present noise environment is then more like that of an urban residential area than a rural one (see Table 5-3). Table 6-1 shows that the appropriate total noise sensitivity correction varies from 0 to +10 dB depending on the noise source.

(iv) North Ashcroft Subdivision

A relatively new subdivision containing an elementary and a secondary school as well as a hospital lies at the north end of Ashcroft It will be exposed to water pipeline construction noise for several days as the line is laid across the agricultural land to the north. However, the major noise impact will come, if the J & B Lumber site in the existing industrial zone is selected for the equipment off-loading facilities, from the trucking of equipment through the subdivision to the highway. Although the truck access route has not yet been finalized, it would likely follow, at least temporarily, the old highway which passes directly by the elementary school and the hospital (see Figure 6-3).

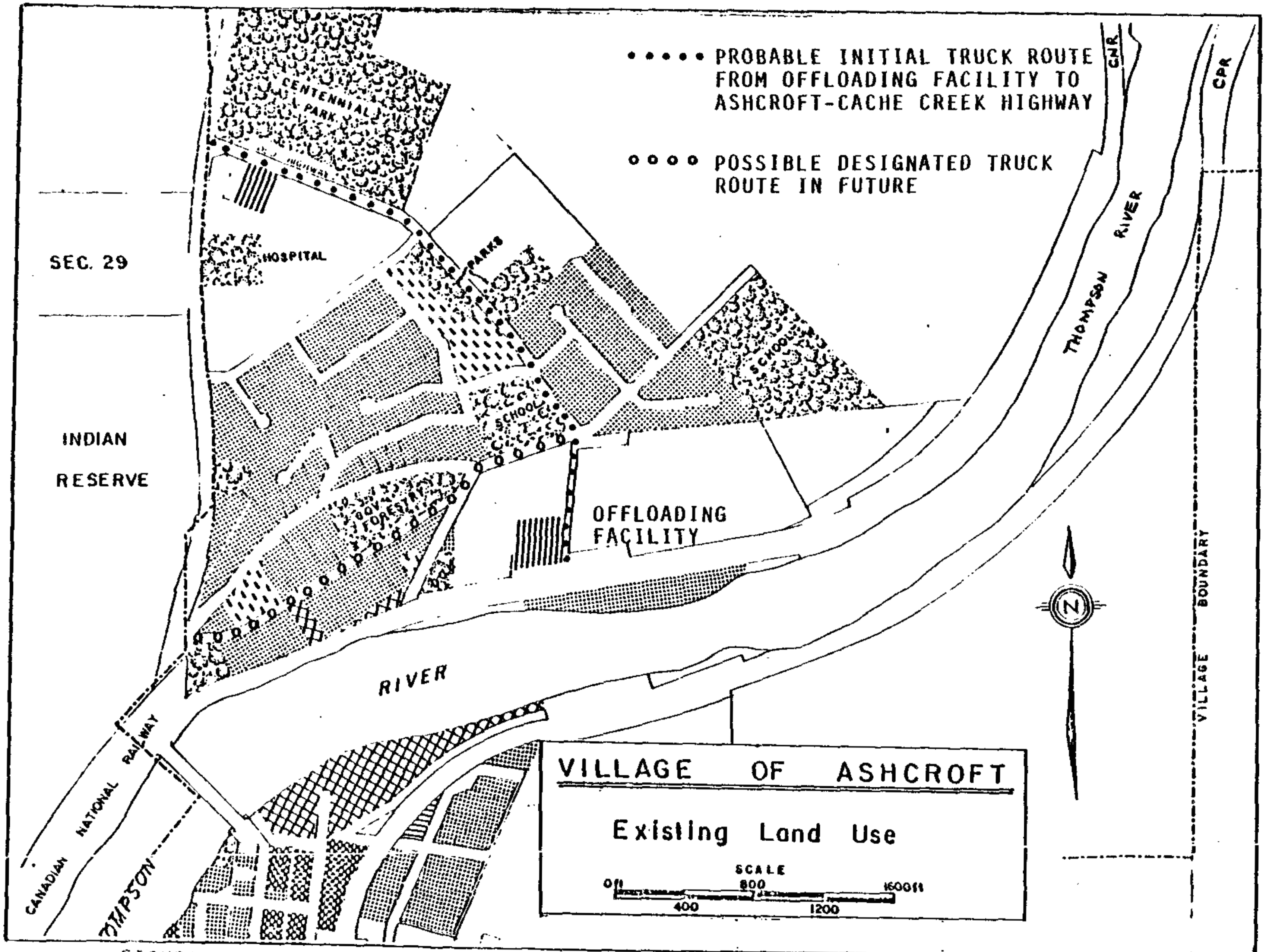


FIGURE 6-3: POSSIBLE EQUIPMENT OFFLOADING SITE ON CNR LINE AT ASHCROFT SHOWING NEIGHBOURING SUBDIVISION AND POSSIBLE TRUCK ROUTES THROUGH IT.

Existing noise levels in this area were not measured but they are likely to be similar to that observed at monitoring site 5 due to the proximity of the railway lines and the industrial zone*. Although no traffic volume data is available for the probable access road to the highway from the existing industrial area, it is likely that it now supports some truck traffic. The community will, therefore, have had some prior experience with the type of noise to be created by the project. The total noise sensitivity correction will, therefore, be that of a suburban community located at varying distances from light industrial and transportation noise sources with some prior experience with the intruding noise; i.e. 0 to +5 dB (see Table 6-1).

(v) Residences along Highway 1 East of Cache Creek

If the project airstrip is located at airstrip Site C, near Highway 1, east of the Cache Creek village boundary, the farmers, ranchers and other rural residents in the Western end of the Semlin Valley will be exposed to some light aircraft noise. The existing noise levels due to heavy Highway 1 traffic (particularly in summer) are quite high, being roughly L_{dn} 60 at 150 m (160 ft.) from the highway**. Since the area would have had little prior exposure to light aircraft noise, the appropriate total noise sensitivity correction would be 0 dB.

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* The industrial zone has been recently purchased by the provincial government and presently is largely undeveloped.

** This figure was obtained by using the Summer 1976 traffic volumes at Savonna provided by Strong Hall & Associates in the CMHC model for road and rail noise. (See Reference 2 & 24)

(vi) Pavilion Indian Reserves 3, 3A and 4

The Pavilion Reserves are located on Highway 12 from 2.5 km. (1.6 miles) to 8.8 km. (5.5 miles) north-west of the junction with the Hat Creek Road. (See figure 6-1). The total population of the three reserves in 1973 was 125[93]. The distribution of occupied dwellings over the reserves is not known, but as at Bonaparte Reserves 1 and 2, the great majority likely lie close to Highway 12. The distances between these reserves and the mine and plant sites and the noise shielding provided by intervening hills will assure that the land-use compabitility at these residential locations will not be reduced by the project. Traffic along Highway 12 past these reserves is not expected to increase significantly due to the project as construction supplies and workers will predominantly enter the study area from the east.

(b) Grazing Lands

In Section 5.2 b (ii), the maximum noise level compatible with the use of land for grazing was conservatively established as YDNL 65. Under the conservative assumption of no sound attenuation due to wind, the areas within which the project operation noise levels will exceed YDNL 65 will be restricted approximately to within 600 m (2000ft.) of the mine pit rim and to within 390 m (1280ft.) and 1200 m (4000 ft.) from the western and eastern plant fencelines respectively. The strip around the mine pit rim is largely high quality cattle grazing land while the area around the Harry Lake plant site is at more than 1370 m (4,500 ft.) elevation and provides only spring range of which the great majority is characterized as poor quality.

(c) Agricultural Lands

The maximum noise level compatible with agricultural land use has been set at L_{eq}(24) 70 which, for relatively constant-level noise, roughly corresponds to YDNL 76. At present, there are no agricultural lands which will be exposed to such a high level of project noise. It is, however, possible but not probable that some of the small bits of existing grazing land on which project noise levels may approach YDNL 76 will be considered by their owners or leasors for conversion to agricultural land use.

(d) Wilderness and Recreational Lands

Little of the land in the Hat Creek Valley region could be called wilderness since cattle grazing occurs throughout the area except on the highest hilltops. However, there are several places in the study area that presently provide recreation[94]. These are presented below and the possibility of project noise impact at each is discussed.

(i) Marble Canyon Provincial Park

Located on Highway 12 6.4 km. (4 miles) north-west of the Hat Creek junction, Marble Canyon Provincial Park provides camping and swimming opportunities. It is beyond the range of audibility of mine and plant noise and the traffic on Highway 12 to the east of Hat Creek is not expected to be increased significantly by the project. Therefore, no noise impact is predicted.

(ii) Pavilion Indian Reserves 3, 3A and 4

It is not known to what extent the Pavilion Reserve land is used for recreation or grazing. The distance from the mine and plant sites and the intervening hills will make any noise from these sources insignificant compared to local traffic noise. At some points during the filling of the Houth Meadow dump, mobile equipment noise will find its way between the hills to these reserves so that some environmental degradation will occur.

(iii) McLean Lake Indian Reserve

The McLean Lake Indian Reserve is located over 6.4 km. (4 miles) due east of the plant site and is used by the native people for grazing and recreation. Plant and mine noise will be insignificant at this distance. However, the project access road will pass close by the southern edge of the reserve so that road construction and traffic noise will significantly increase the environmental noise levels over the southern portion of the reserve. The impact of this noise may be offset somewhat by the improved access to the reserve.

(iv) Future Campsite

The provincial Forest Service may establish a campsite along the road to the Cornwall Summit, about 1.6 km. (1 mile) north of Oregon Jack Road. The nearest project facility would be the airstrip, if it was located at Site A, about 8 km. (5 miles) to the north-east. Therefore, no noise impact is predicted.

(v) The Clear Range

Scenic hiking and riding trails exist over the crests of Mt. Blustry, Cairn Peak, Moore Peak, and Chipuin Mtn. which form the height of land to the west of the Hat Creek Valley. Because of the unobstructed sitelines from the mountain peaks down into the Hat Creek Valley, the mine noise may at times be audible even though the pit will be over 6.4 km. (4 miles) away.

6.2 NOISE IMPACT OF FIRST YEAR OF PROJECT (PEAK CONSTRUCTION NOISE)

The first year of the project is considered to be the 1978-1979 construction year. Although the starting date may be postponed, the sequence and scale of activities is assumed to remain as indicated on Integ Ebasco's July 7, 1977 construction schedule and B.C. Hydro's master schedule of the Hat Creek Thermal Project.

Some of the offsite facilities will not be started until after 1979. In general, the noise impacts of the offsites are independent of those of the plant and mine. Therefore, for each offsite facility, the first year of the project is considered to be the year in which construction starts on that offsite.

In all cases, the first year of construction (for those activities lasting more than one year) will generate the highest construction noise levels.

(a) Site and Environs

The total noise levels in the area of the plant and mine sites and their environs will in general be comprised of contributions from several different project activities. During the first year of the project, these activities will be:

1. Plant construction (excavation and foundations)
2. mine mouth preparation (filling of north valley dump)
3. access road construction
4. mine camp construction
5. project-related traffic on Highway 12.

The noise levels to be generated by each of these activities were estimated as described in Section 4.2. The contribution of each activity's noise to the total YDNL at a given receptor location was obtained by applying the sound propagation model of Section 4.1 f. The various contributions were then added logarithmically to yield the total YDNL at each receptor location. The resulting YDNL's and their impacts at each significant receptor location are presented below.

(i) Bonaparte Indian Reserve 1

The project noise levels on the western end of Bonaparte Reserve 1 during the first year will be controlled by the noise of earth-moving equipment engaged in filling in the North Valley Dump. Project-related traffic controls project noise levels near the highway over all but the western end of the reserve and plant construction noise becomes significant along its south-eastern edge. These project noise levels will vary from YDNL 62 at the south-west corner of the reserve to YDNL 35 at the north-east corner. The variation of project YDNL over Reserve 1 is shown in Figure 6-4. By adding the existing YDNL contour values of Figure 6-2 to those of Figure 6-4, the combined YDNL's that will exist during the first year of the project are obtained. These are shown in Figure 6.5.

A. Land Use Incompatibility

Residential Land

The areas of Reserve 1 in which the combined first year noise levels will exceed YDNL 55 and hence which will be considered incompatible with residential land use are shown hachured in Figure 6-5. There is presently only one occupied house (four to six people)

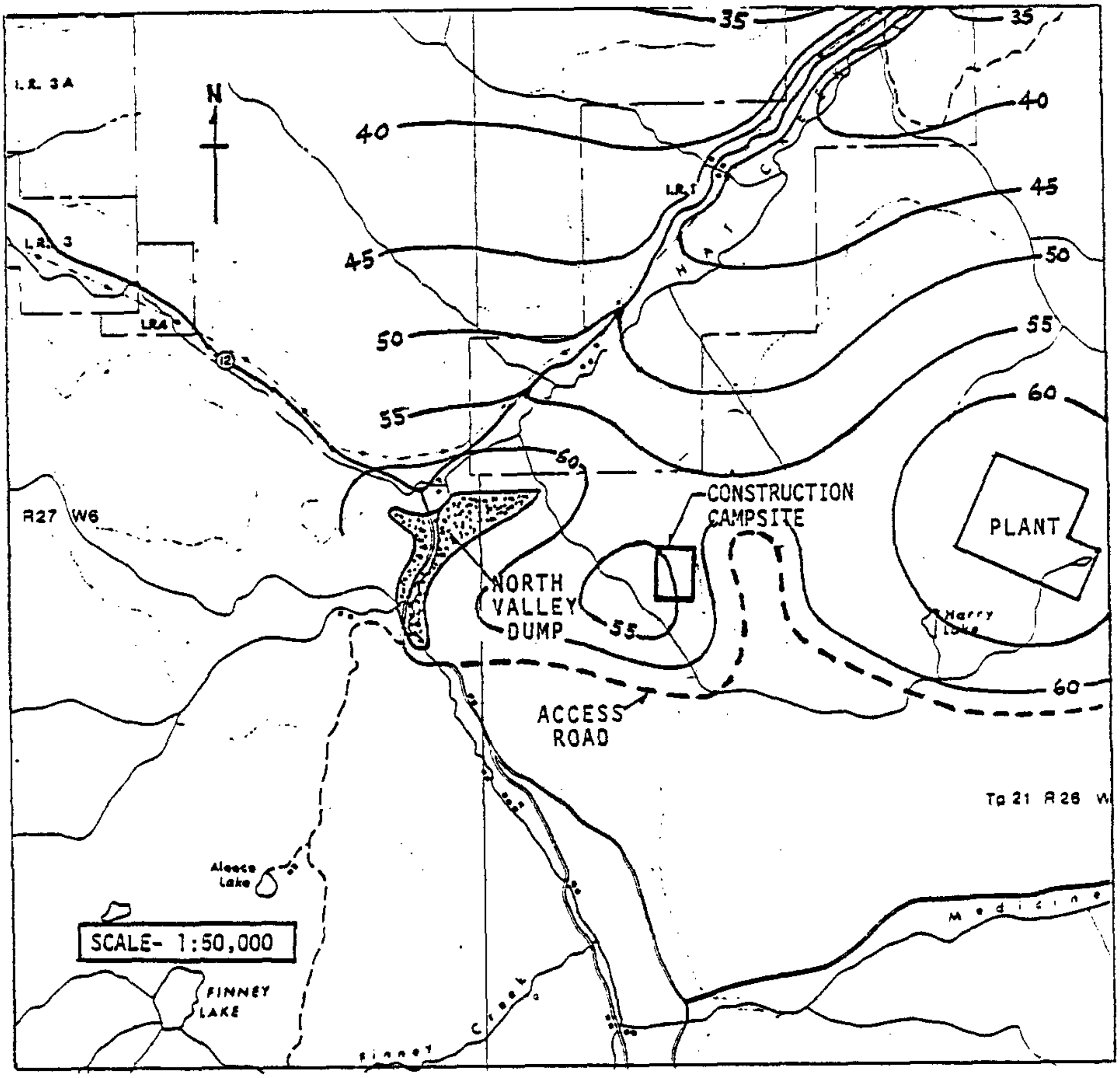

FIGURE 6-4: NORTH VALLEY DUMP-FILLING AND PLANT CONSTRUCTION NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 DURING 1978-79.

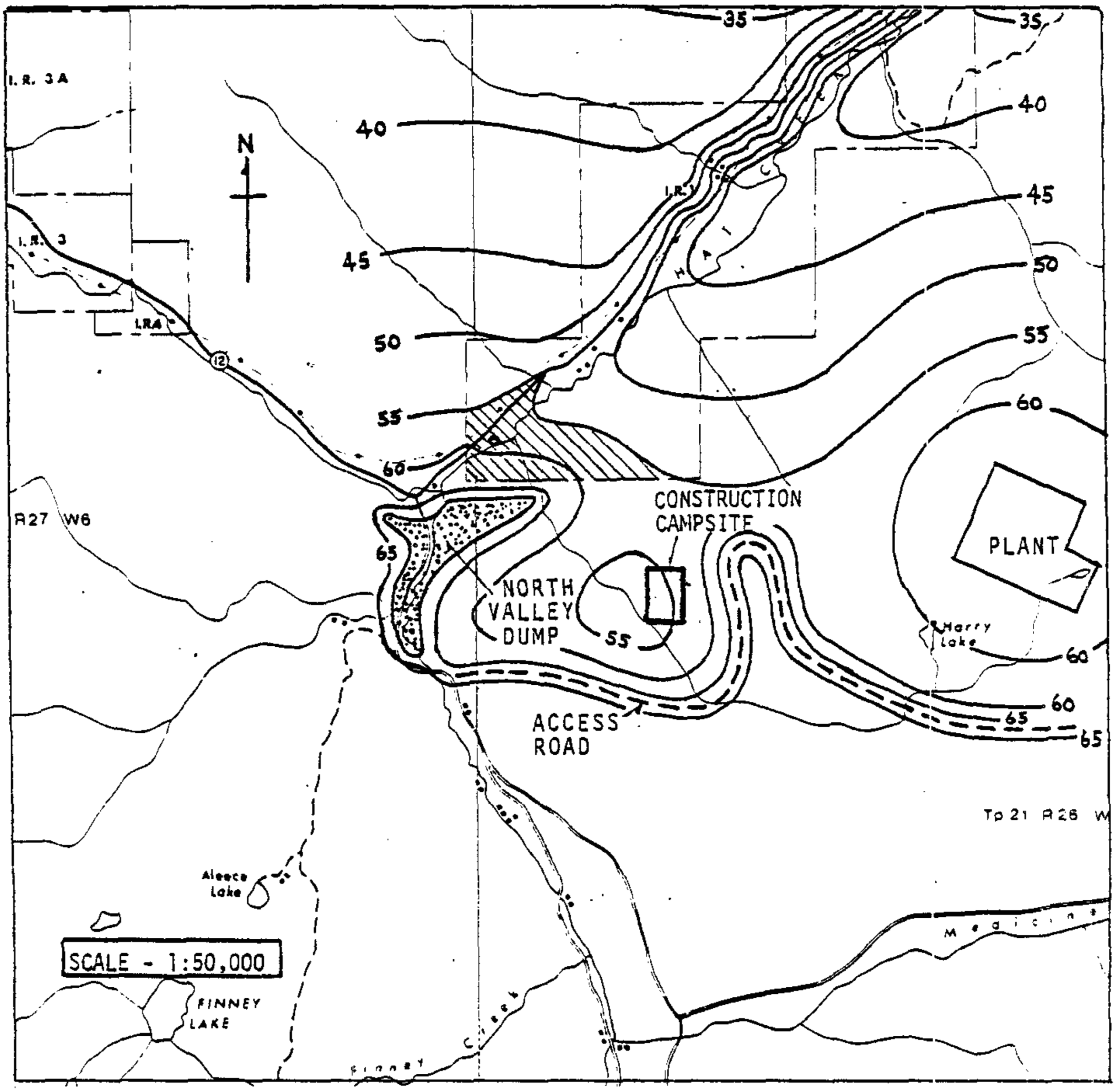

FIGURE 6-5: COMBINED, WITH-PROJECT NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 DURING 1978-79. HACHURED AREA IS INCOMPATIBLE WITH RESIDENTIAL LAND USE.

within this incompatible area. These figures are based on the identification of from five to seven occupied houses on Reserve 1 by visual inspection in 1977 and on an estimated total population on Reserve 1 of 30 (source; Strong Hall & Associates).

Grazing Land

Cattle and horses are grazed over much of Reserve 1, but since the maximum combined noise level on the reserve (see Figure 6-5) will not exceed YDNL 65, none of the reserve land will be made incompatible with grazing.

B. Annoyance and Community Reaction

Average Noise Levels

The normalized YDNL's to be expected on Reserve 1 are obtained by adding the sensitivity correction of +10 dB (see Table 6-1) to all project YDNL contours in Figure 6-4 which fall within the reserve boundaries. The normalized YDNL's of the intruding noise in Reserve 1 will then be seen to vary from 72 to 45 dB. By referring to Figure 5-1, it is seen that the expected community reaction should vary from "threates of legal action" to "no reaction" over this range of normalized YDNL's. However, because of the low population density but probable high community cohesiveness of the reserve residents, a continuous range of reactions cannot be expected. The residents will likely react as a group and the severity of their reaction to the project noise will likely fall closer to the upper end of the predicted range.

Intermittent Noise Levels

The only sources of significant intermittent noise during the first year of the project will be blasting and perhaps warning or shift signal devices. These noises will occur only during the daytime so that the criteria adopted for evaluating the major impact of intermittent noises, i.e. sleep disturbance (see Section 5.2 d), do not apply. However, reasonable measures should be taken to minimize the impact of these noises and their levels and frequencies of occurence should be monitored (see Section 7.0).

(ii) Bonaparte Indian Reserve 2

A. Land Use Incompatibility

The only project noise that will reach Reserve 2 will be the traffic noise from project-related vehicles using Highway 12. Based on Strong Hall and Associates traffic predictions for the first year of the project, the increase in traffic YDNL's along Highway 12 will be only 1.5 dB. By adding this 1.5 dB to the existing traffic noise contour values of Figure 6-2, it is seen that the criterion for residential land use compatibility (YDNL 55) will be exceeded only very near the edge of the highway. Presently, YDNL 55 is obtained at about 21 m (70 ft.) from the highway. The project traffic will increase this distance to about 27 m (90 ft.). From the available information, there are no dwellings within 27 m (90 ft.) of the highway.

B. Annoyance and Community Reaction

The increase in YDNL of 1.5 dB will not likely be perceptible to the residents of Reserve 2. Since the residents are very familiar with traffic noise, the appropriate sensitivity correction for this situation is +5 dB. The maximum normalized YDNL on Reserve 2 is then less than 55 dB and hence, according to Figure 5-1, no community reaction is anticipated.

(iii) Hat Creek Valley Ranches

As of March 1978, there were only five occupied ranch houses in the Hat Creek Valley that will be within audible range of project activities during their first year. The locations of these five dwellings are shown in Figure 6-6 and they are listed in Table 6-2 according to occupant and distance from the Hat Creek Road-Highway 12 junction. Also listed in Table 6-2 for each house are the approximate existing YDNL, the predicted project YDNL and normalized YDNL (obtained by adding 15 dB to the predicted YDNL) and the combined YDNL created by project and background noise together. The dominant project noise source at the first three locations will be north valley dump filling while plant construction will be most significant at the most southerly locations. The predicted level of community reaction to project noise is given in the final column of Table 6-2; these reactions were obtained from Figure 5-1 and were based on the assumption that the residents of each range will respond independently. If, however, the residents of all five houses respond as a group, the level of reaction will likely be nearer the high end of the range of individual reactions of Table 6-2.

A. Land Use Incompatibility

<u>Residential Land</u>

Since none of the combined YDNL's of Table 6-2 exceed the 55 dB criteria, all Hat Creek Valley ranch house locations will be compatible with residential land use throughout the construction of the mine mouth facilities.

<u>Grazing Land</u>

The cattle-grazing criteria of YDNL 65 will only be exceeded within about 150 m (500 ft.) and 75 m (250 ft.) of the project activity areas of the north valley dump and access road, respectively. These incompatible areas can be seen in Figure 6-5.

RANCH HOUSE	OCCUPANT	DISTANCE FROM HIGHWAY 12 JUNCTION m (ft.)	EXISTING YDNL	PROJECT YDNL	COMBINED YDNL	NORMALIZED PROJECT YDNL (+15 dB)	EXPECTED RESIDENT REACTION
1	Ed Lehman	3,650 (12,000)	35 - 40	46	46 - 47	61	Sporadic complaints to widespread complaints
2	M. Saulte	4,900 (16,000)	35 - 40	41	42 - 43.5	56	No reaction to sporadic complaints
3.	Ike Lehman	4,900 (16,000)	35 - 40	41	42 - 43.5	56	No reaction to sporadic complaints
4	A. Parke	8,540 (28,000)	35 - 40	32	37 - 40.5	47	No reaction
5	D. Ridlar (Baldwin)	9,760 (32,000)	35 - 40	30	36 - 40	45	No reaction

TABLE 6-2: NOISE LEVELS AT HAT CREEK VALLEY RANCH HOUSES IN FIRST YEAR OF PROJECT (1978-1979) AND EXPECTED REACTIONS OF RESIDENTS.

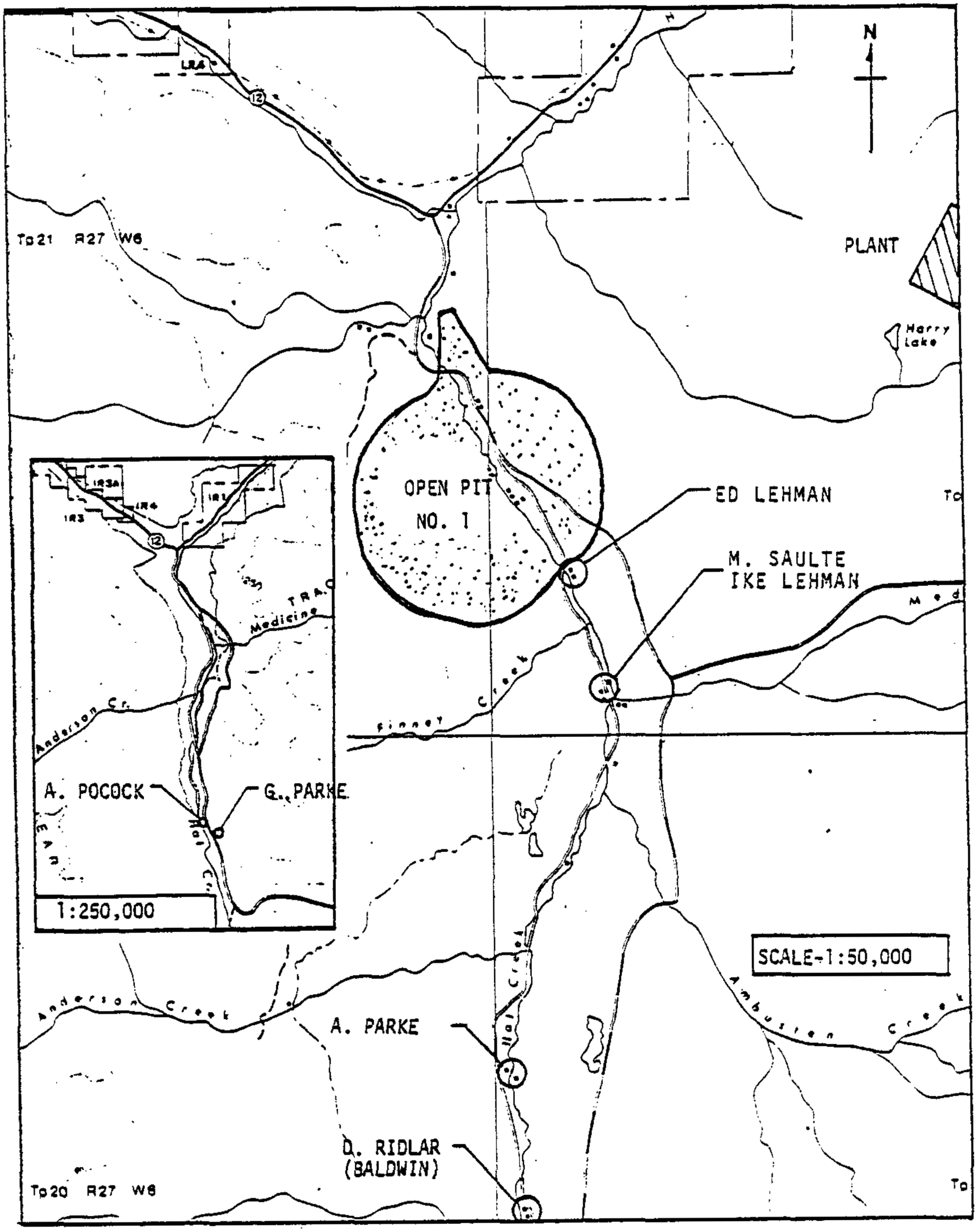

FIGURE 6-6: OCCUPIED UPPER HAT CREEK VALLEY RANCH HOUSES AS OF MARCH 1978

Ranch fencing will be typically installed within 50 to 100 m (160 to 330 ft.) of the pit and dump operations, thus precluding cattle grazing[94a].

B. Annoyance and Community Reaction

Average Noise Levels

As shown in Table 6-2, the reactions of individual ranchers to first year project noise should range from none at the two most southerly locations to sporadic or widespread complaints at the three locations nearest the project. Again, because of the small numbers of residents involved and their historical cohesiveness it is reasonable to expect them to act collectively and for that reaction to be representative of the more highly impacted residences.

Intermittent Noise Levels

The comments made in Section 6.2 a (i) B above regarding Reserve 1 apply here also.

(iv) Trachyte Hills

During the first year of plant construction, noise levels will exceed the grazing land use criteria of YDNL 65 up to a maximum of about 210 m (700 ft.) beyond the plant property lines (see Figure 4-2). In subsequent construction years, this impacted zone will diminish. At the 1400 m (4600 ft.) elevation of the plant site, the grazing capability of the land is roughly 10% high quality and 90% low quality[95]. Therefore, the degradation of the grazing capacity of the region by plant construction noise will be minimal.

(b) Offsite Facilities

(i) Make-up Cooling Water Supply System Construction

The several components of the make-up cooling water supply system will, in the main, not be constructed concurrently:

1. River Bottom Preparation - November 1978 to April 1979,
2. Water Intake Construction - August 1980 to May 1981,
3. Pumping Station Construction - April 1981 to April 1982,
4. Pipeline Construction - April 1981 to November 1981.

Only during the month of April 1981 will the various construction activities near the Bonaparte-Thompson Confluence overlap in time. Therefore, the impact of each activity has been considered independently from the others.

Assuming that adequate noise control measures will be taken to minimize the impact of the operating noise of these facilities, it is concluded that their noise levels during operation will be substantially lower than during construction. Therefore, these construction activities have been considered as temporary sources of noise impacts and hence a community sensitivity correction of -5 dB has been applied in each case as was proposed in Section 5.4 b.

A. River Bottom Preparation

Figure 6-7 shows the proposed locations of the various components of the water supply system near the confluence of the Thompson and Bonaparte Rivers [96]. It also shows the nearby residential area which presently contains six occupied dwellings and an

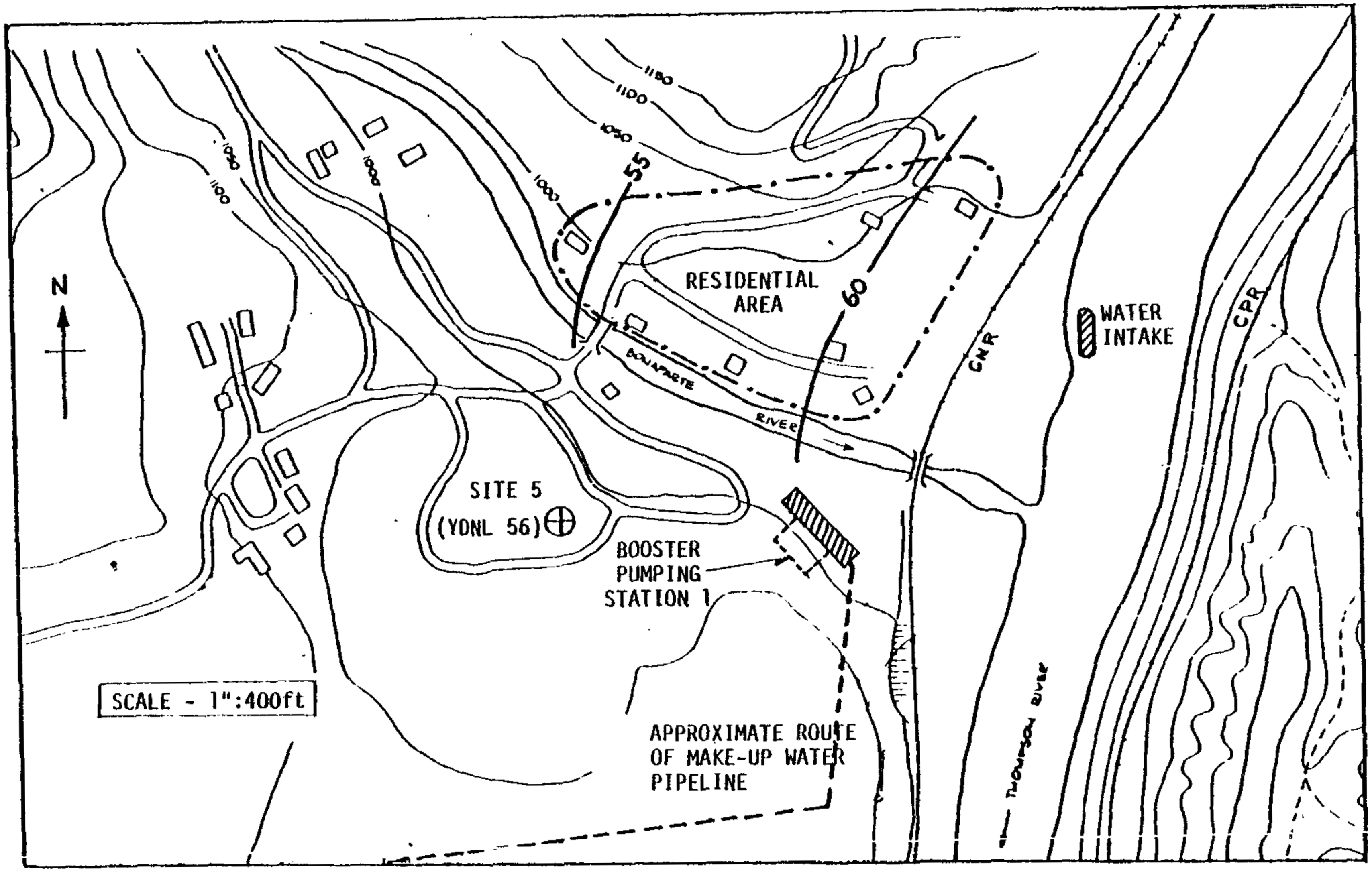

FIGURE 6-7: EXISTING (1976) TRAIN-NOISE DOMINATED YDNL'S IN RESIDENTIAL AREA AT CONFLUENCE OF BONAPARTE AND THOMPSON RIVERS.

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estimated total population of 16 to 18[97] and which is considered the primary noise receptor area for the riverside water supply system activities. The noise source to receptor distance is then considered to vary from 150 m (500 ft.) to 425 m (1400 ft.).

Neglecting any shielding that may be provided by the river bank, the noise level from this seven month construction job will vary from YDNL 56 at the eastern edge of the residential area to YDNL 46 at the western edge.

Land Use Incompatibility

Based on the existing noise level of YDNL 56 measured at monitoring Site 5 and on the theoretical attenuation rate of train noise from the two nearby railways, it is estimated that train noise levels in the residential area presently range from YDNL 62 to 55. This range of train noise levels was confirmed by inserting the average daily train traffic figures obtained from CNR and CPR (see Section 3.2 b) into the CMHC rail noise model (Reference 24). Therefore, the existing environmental noise levels ar: incompatible with residential land use over most of the area concern. By adding these existing noise level extremes to the predicted construction noise levels extremes of YDNL 56 and 46 respectively, it is seen that the combined noise levels will range from approximately YDNL 63 to 55. Therefore, the river bottom preparation will increase the existing noise levels by 1 dB or less so that the compatibility of the area for residential land use will not be degraded significantly.

Annoyance and Community Reaction

The yearly average noise levels from river bottom preparation will be below the present levels from train traffic but not so far below as to be inaudible and they will control the daytime background noise levels between train events. Hence, the possibility of annoyance must be addressed. From Table 6-1, the total community sensitivity correction is seen to be 0 dB. Therefore, the normalized project YDNL's will range from 56 to 46. Entering these values in Figure 5-1, the probable range of community reactions is seen to be essentially limited to the "no reaction" category.

Because any intermittent noises (perhaps some blasting) would be confined to a single 8-hour day shift, they are not considered to be a source of significant annoyance.

B. Water Intake Construction

Land Use Incompatibility

The construction of the cooling water intake is to take 10 months and will produce noise levels which will vary from YDNL 65 to 54 across the residential area near the confluence of the Thompson and the Bonaparte. The combined noise levels from the existing train traffic (see Figure 6-7) and the intake construction will then vary from YDNL 67 to 58 as shown in Figure 6-8. Therefore, the area will be made more incompatible with residential land use by from 3 to 5 dB.

Annoyance and Community Reaction

It is not considered that one project activity will provide "prior noise exposure" for a later project activity of the same type (e.g. construction) and hence, will reduce the sensitivity of receptors to the latter noise. The community sensitivity correction is, therefore, +5 dB; a correction for impulsive noise content has been made due to the planned use of a pile driver (see Table 6-1). The normalized project YDNL's will then vary from 70 to 59 across the residential area and Figure 5-1 predicts that community reactions will vary from threats of legal action to sporadic complaints.

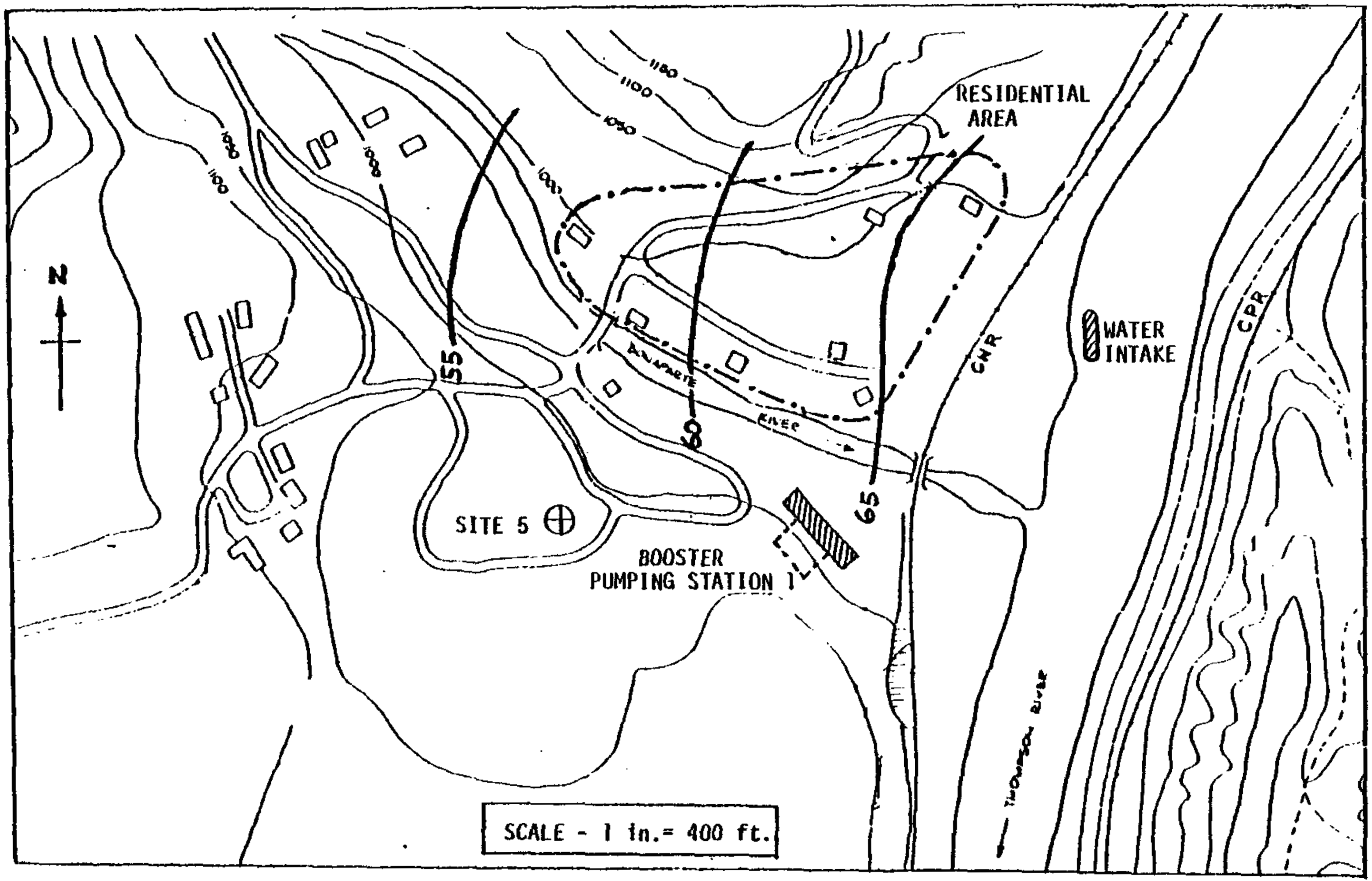

FIGURE 6-8: MAKE-UP COOLING WATER INTAKE CONSTRUCTION: COMBINED, WITH-PROJECT YDNL CONTOURS.

C. Booster Pumping Station 1

Booster Pumping Station 1 is to be located as shown in Figure 6-7. The residential area is from 90 m (300 ft.) to 270 m (900 ft.) away. Construction is to take one year and will produce noise levels in the residential area ranging from YDNL 69 to 57. The combined construction and train noise YDNL will then vary from 70 at the south-east corner to 60 at the south-west correr to 63 at the north-east corner as shown in Figure 6-9.

Land Use Incompatibility

During the year of construction of Booster pumping station 1, the degree to which the environmental noise levels at the Bonaparte Thompson confluence area are incompatible with residential land use will increase by from 5 to 8 dB.

Annoyance and Community Reaction

Using a sensitivity correction of zero, the normalized project YDNL is seen to vary from 69 to 57 with the corresponding community reactions ranging from threats of legal action to sporadic complaints.

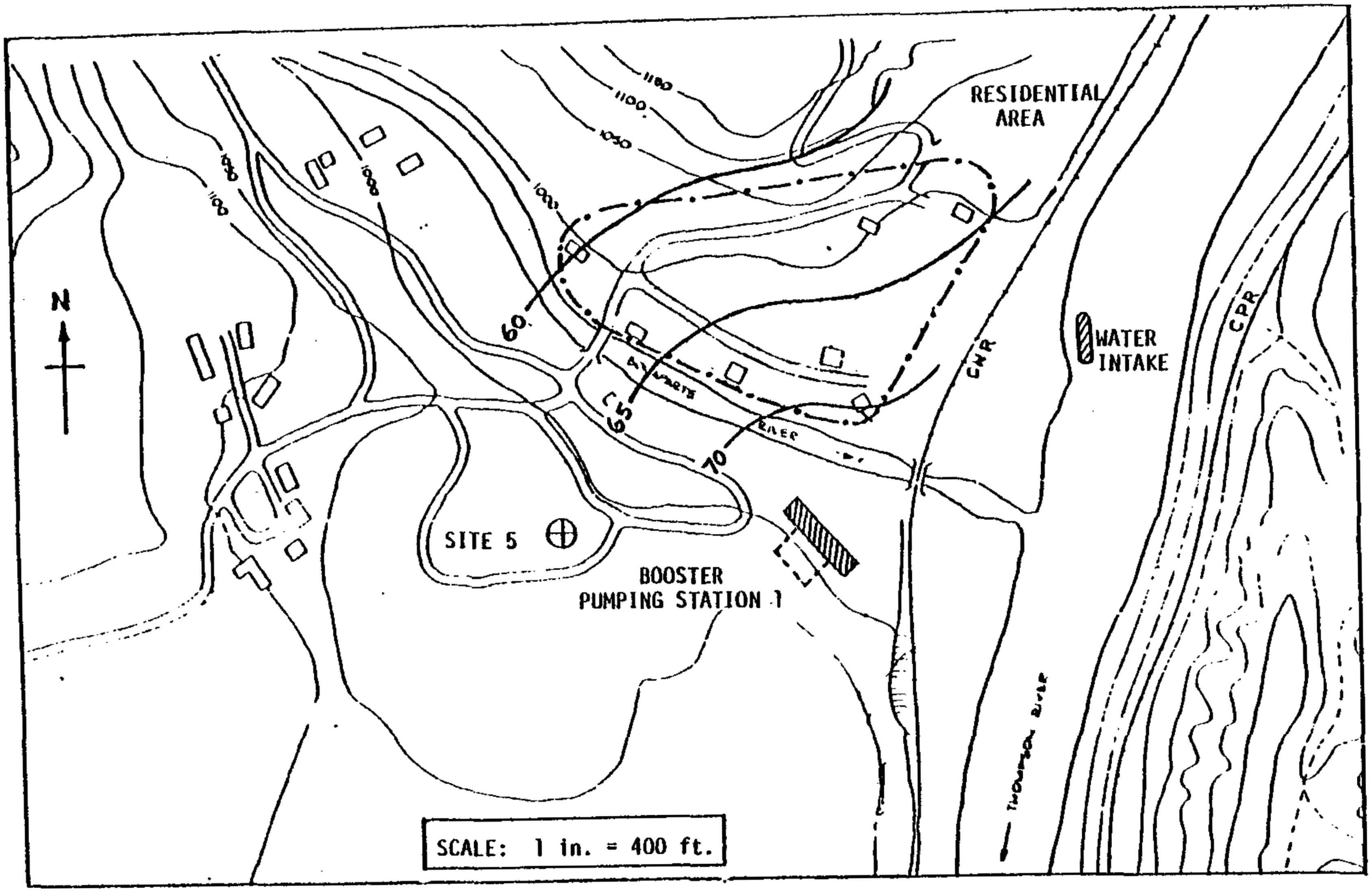

FIGURE 6-9: BOOSTER PUMPING STATION 1 CONSTRUCTION: COMBINED, WITH-PROJECT YDNL CONTOURS.

D. Booster Pumping Station 2

The second booster pumping station is to be located in a range area of the Cornwall Hills above Boston Flats. The construction noise levels are considered to be the same as for Station 1.

Land Use Incompatibility

The criterion for noise level compatibility with cattle grazing is YDNL 65 or less. Neglecting the contribution of any blasting required*, YDNL 65 will be exceeded for roughly 150 m (500 ft.) around the active construction zone. Assuming an active construction zone of 150 m (500 ft.) in radius, the total area alienated from grazing during pumping station construction will be less than 0.3 $km.^2$ (0.12 square mile). Since this alienation will last for only one year it is not considered to be a significant impact on grazing land use.

E. Water Pipeline Construction

It is proposed that the water pipeline be layed at a rate of 610 m/day (2000 ft./day) so that the 23 km (14 miles) of pipe can be completed within the 8 month period now alloted[98]. The active construction zone being approximately 0.4 km (0.25 mile) in length, will then pass a given point in less than one day and will be within audible range of a given point for only about 2 weeks.

Over the length of the pipeline its construction noise will be imposed on four separate receptor areas: the residential area at the Thompson-Bonaparte confluence, the North Ashcroft subdivision, the Cornwall Hills grazing lands and the McLean Indian Reserve.

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* The type and amount of blasting required, if any, was not known at the time of preparation of this report.

Thompson-Bonaparte Residential Area

The major exposure of the Thompson-Bonaparte residential area to pipeline construction noise will occur during the completion of the section of line between the water intake and pumping station 1. The nearest residences (see Figure 6-7) will be only about 60 m (200 ft.) from the pipeline route and will be exposed to YDNL 58. The most distance residences will be exposed to YDNL 51. However, the concurrent construction of pumping station 1 will, as was shown in Section above, result in combined noise levels ranging from YDNL 70 to 63 along the eastern edge of the residential area. Therefore, the addition of the pipeline construction noise will not significantly alter the residential land use incompatibility situation as shown in Figure 6-9. Likewise community reaction over the year in question would not be expected to increase significantly.

During the few days when the pipeline construction zone will be directly adjacent to the residential area, the daily average noise levels will range from L_{dn}75 to 68. These levels will then be 12 or 13 dB above the daily background noise levels established by train traffic and hence, could result in some short term community action in addition to any action being taken as a result of pumping station construction noise.

North Ashcroft Subdivision

Pipeline construction noise levels in the subdivision at the north end of Ashcroft will vary from YDNL 54 at the northern edge to 41 along the Thompson River side. The project noise will, therefore, increase the range of noise level in the area from an estimated YDNL 50 to 56 to 50 to 58. The land use incompatibility will, therefore, be increased by a maximum of 2 dB.

Since these portions of the subdivision which are nearest the pipeline route are well removed from the industrial area and railway lines near the thompson River, they are considered to presently have the background noise level of a normal suburban community. They also have no prior experience with the intruding project noise. Reference to Table 6-1 shows that the appropriate total community sensitivity correction is +5 dB. The normalized project YDNL's will then vary from 59 to 46 from the northern to the southern edges of the subdivision. Entering these values in Figure 5-1, it is seen that the community reaction can be expected to be limited to the sporadic complaints and no reaction categories.

Cornwall Hills Grazing Areas

The potential for disruption of grazing will only exist at a particular location near the pipeline route for the roughly two week period while the pipe-laying noise will be clearly audible. Therefore, to determine the area within which the noise may be incompatible with grazing, the daily noise level descriptor, L_{dn}, is used. The region within which the project L_{dn} will exceed 65 dB [see Section 5.2 b (ii)] will extend for approximately 450 m (1500 ft.) on each side of the pipeline route. Therefore, at any point along the route, a strip of land 900 m (3000 ft.) wide will become incompatible with grazing for a period of up to a week; assuming a laying rate of 610 m/day (2000 ft./day). Considering that the Cornwall Hills area is essentially open range so that the cattle are quite free to move, this very temporary loss of grazing capacity will not be significant.

McLean Lake Indian Reserve

The McLean Lake Indian Reserve is used for grazing and recreation by native people. The pipeline is to be located parallel to and about 210 m (700 ft.) from the southern boundary of the reserve. The southern boundary is 2.2 km. (1.375 miles) long so that the pipe-laying operation will take about one work week to pass by the reserve.

Again, based on a grazing compatibility criterion of L_{dn} 65 for the days when the operation is adjacent to the reserve, it is seen that a 250 m (800 ft.) strip along the south edge of the reserve will be incompatible with grazing for less than a week at any point. Since this very temporarily incompatible strip represents only 12% of the total area of the McClean Lake and the adjacent Grasslands Reserves, the impact of pipeline construction on grazing is not considered significant.

Annoyance to native peoples using the McLean Lake Reserve for recreation will not be significant provided that the two to three week period during which pipe-laying noise will be clearly audible on the reserve is not scheduled to conflict with any major recreational or social events.

(ii) Airstrip Construction

Two airstrip sites are still being considered. These are Site A, 14 km. (8.75 miles) south of Cache Creek near Highway 1 and Site C, 4 km. (2.5 miles) east of Cache Creek on Highway 1. Site A is located on grazing land with no residences in the vicinity, while Site C is on fully irrigated agricultural land with the nearest ranch buildings only 300 m (1000 ft.) from the western end of the runway. Airstrip construction is scheduled from April 1979 to April 1980 and will consists of two phases: excavation and base course (about 8 months) and paving (about 4 months). Noise levels from the two phases of construction have been combined tc give the total YDNL for the full 12 months of constructon.

A. Site A

Land Use Incompatibility

The only noise impact consideration at Site A is the rendering of land incompatible with grazing. The criterion is then YDNL 65. This level of noise will be exceeded up to a distance of about 150 m (500 ft.) on each side of the airstrip. Since the airstrip is to be 1500 m (5000 ft.) long, the area of grazing land which will be made incompatible with grazing for the 12-month construction period will be 0.6 $km.^2$ (0.23 square miles).

B. Site C

Land Use Incompatibility

At Site C, airstrip construction noise can impact two land uses, agricultural and residential.

The agricultural land use noise criterion of $L_{eq}(24)$ 70 will be exceeded within about 53 m (175 ft.) of the edges of the active construction zone which is taken to be 100 m (330 ft.) wide (see Figure 6-9A). Noise levels at the edge of the "cleared area" will be approximately $L_{eq}(24)$ 74. Since it is possible that farming activity may take place within this incompatible zone, at least on the south side of the airstrip, a potential for noise impact

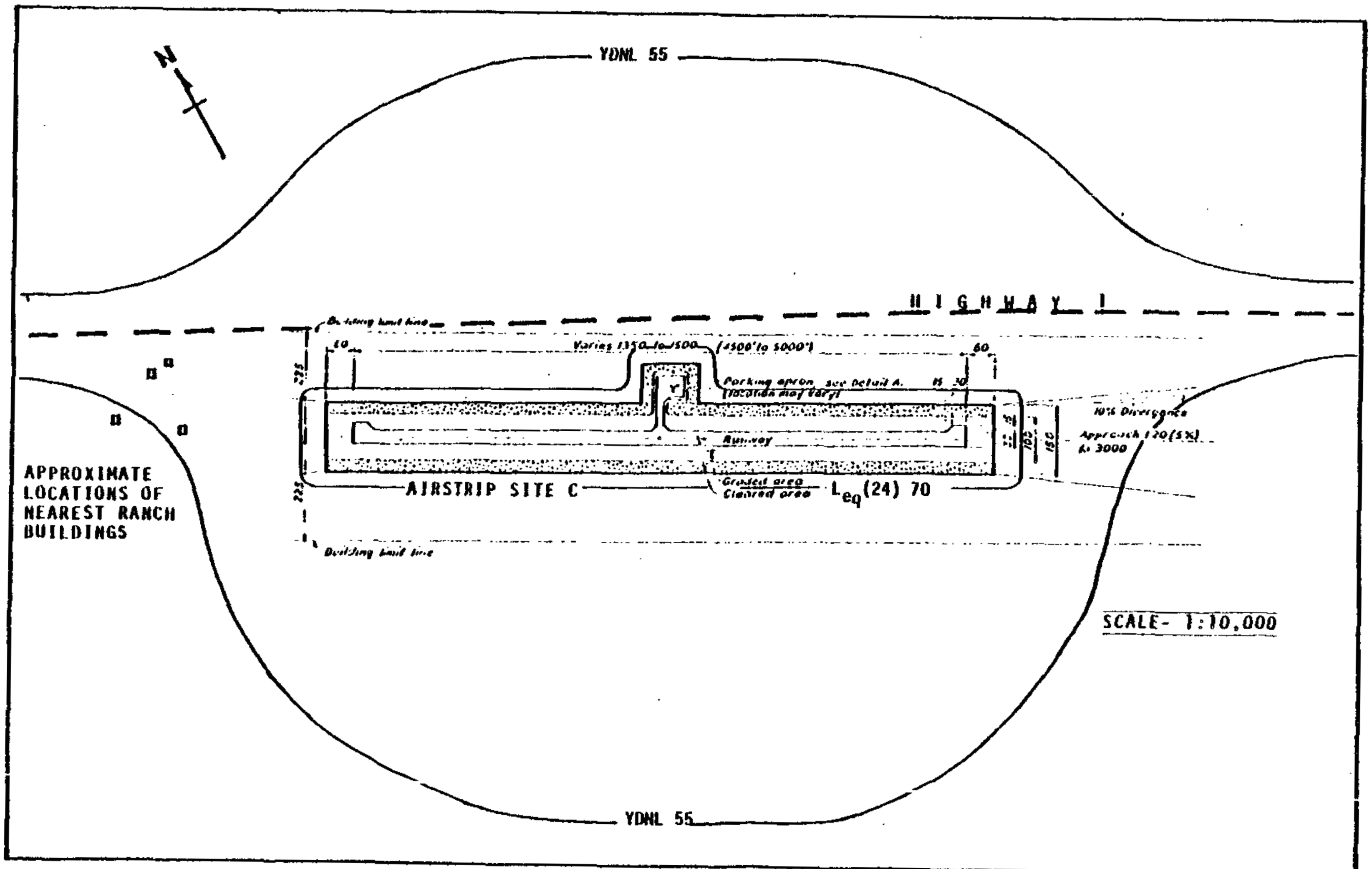

FIGURE 6-9A: AREA OF RESIDENTIAL LAND USE INCOMPATIBILITY (YDNL >55) DURING AIRSTRIP CONSTRUCTION AT SITE C

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exists. It is not known how much time a farmer may spend in this zone during the one year airstrip construction period. However, based on the highest expected noise level in this zone of $L_{eq}(24)$ 74, a daily exposure of about 3 hours for the entire year would be required to constitute a hearing loss hazard.

The nearest ranch buildings to Site C are about 300 m (1000 ft.) west of the airstrip and they will be exposed to construction noise levels of YDNL 54. However, the residents of this ranch are presently exposed to Highway 1 traffic noise levels of from YDNL 60 to 48. Therefore, depending upon the exact location of the ranch house, these residents may or may not already be exposed to permanent noise levels incompatible with residential land use (i.e. YDNL >55).

The combined noise levels of traffic and construction will range from YDNL 61 to 55 from the nearest to the farthest building locations from Highway 1. Therefore, the potential exists for airstrip construction noise to render a previously compatible residential location incompatible. Whether or not this will occur depends upon which of the buildings indicated in Figure 6-15 are presently occupied residences. The area of residential land use incompatibility during the airstrip construction is shown in Figure 6-9A.

Annoyance and Public Reaction

Although existing noise levels near Highway 1 are high, they are not high enough to render airstrip construction noise unidentifiable. A -5dB correction is applied due to the high existing noise levels, but since the ranch residents will have had no prior experience with the intruding noise, the total sensitivity correction is 0 dB. Normalized project YDNL will then be 54 + 0 = 54 dB. Figure 5-1 then shows that the no reaction is expected from the nearest ranch residents. But since we may be dealing with only one or two residences, the actual reaction could vary significantly depending upon the individual natures and attitudes of the few residents.

(iii) Access Road Construction

The access road will be constructed in two phases, excavation and base course (October 1978 to December 1979) and paving (April to November 1980). The excavation and base course work will likely be carried out by four crews working simultaneously; each to complete about 8 km. (5 miles) in 14 months. Therefore, this work phase will be completed at the rate of about 30 m/day (100 ft./day) assuming 5 work days per week and no winter shut downs. The paving work will be done by one crew in 8 months, so that pavement will be completed at the rate of about 125 m/day (650 ft./day). Since the two work phases are to be carried out in different years, their noise impacts have been considered separately.

There are two possible noise impacts which could result from access road construction: incompatibility with grazing and degradation of the recreational area of McLean Lake Reserve.

A. Excavation and Base Course

Land Use Incompatibility

Noise levels from excavation and base course preparation will exceed the daily average noise level criterion for grazing of L_{dn} 65 up to a distance of 400 m (1300 ft.) on either side of the road route. Moving at a rate of 30 m/day (100 ft./day), it will take the 0.4 km. (0.25 mile) long active construction zones of the four crews about 13 work days to pass a given point. It is then conservative to say that each crew, when working in range land, will alienate a 0.8 km. (o.5 mile) wide strip for roughly two months at any point along the route. Therefore, for each kilometer of range land through which the route passes, the grazing capacity loss will be 14 hectare-months (35 acre-months). Assuming the route passes through range land over 75% of its length, then the total lost grazing capacity would be 320 hectare-months (800 acre-months). Again considering the mobility of range cattle, this temporary loss of grazing capacity is not considered to significantly reduce the capacity of the area.

The access road will run adjacent to the McLean Lake Reserve for about 1200 m (400 ft.). See Figure 6-16 for relationship of road to reserve. Its closest approach distance will be about 360 m (1200 ft.)[99]. Therefore, the construction noise levels will exceed L_{dn} 65 for only about 30 m (100 ft.) along the southern boundary of the reserve. Impact on grazing land use will be insignificant.

Annoyance and Community Reaction

During the approximately 50 workdays, when the excavation and base course operations are adjacent to the McClean Lake Reserve, the daily average noise levels at the southern edge of the reserve will vary from L_{dn} 65 to 47 depending on the distance from road to reserve. These are significant increases relative to the estimated natural background level of about L_{dn} 35. Therefore, annoyance could result especially if construction is during summer, when recreational use of the area is more likely.

B. Paving of Access Road

Land Use Incompatibility

The paving operation will move at over six times the rate of the excavation and base course operation and the noise levels associated with the final grading, paving and compacting will be about 5 dB lower. Therefore, the impact of the actual paving operation is judged to be insignificant on grazing land use and recreation.

Highway trucking of gravel and asphalt will take place continuously during the paving operation, first from one end of the access road and then, after the halfway point is reached, from the other. Therefore, areas near the ends of the access road will be exposed to trucking noise for 3 to 4 months. Depending on the hauling distance and the paving rate at a given stage in the operation, there could be from 30 to 60 truck passbys per hour. Assuming a mean value of 45 trucks/hour and near maximum grade (7%)[100], then the grazing land use criterion of L_{dn} 65 is achieved within 30 m (100 ft.) of the roadside. Therefore, the impact of the 4 month trucking operation on grazing land use is judged to be insignificant.

Annoyance and Public Reaction

Applying the above trucking conditions to the case of recreation activities at the McLean Lake Reserve, the noise levels at the southern boundary of the reserve are seen to be L_{dn} 42 for the duration of trucking or YDNL 37, if the entire year is considered. These levels of intruding noise are not considered to be disruptive to any recreational activities on the reserve.

(iv) Creek Diversion Construction

As discussed in Section 4.2 c (iv), the construction of creek diversion facilities will not be a significant source of noise impact because of its concurrence with other construction and mine activities and because of the lack of receptors in the area.

(v) Offloading Facilities

All offloading sites (Ashcroft, Kelly Lake and Spences Bridge; see Figures 3-1 and 3-2) of necessity are adjacent to railway mainlines carrying considerable train traffic (e.g. CPR - 25 movements/day in 1978) so that the preparation of the gravel-surfaced site will not significantly increase local YDNL's. Because the precise locations of the site alternatives are not known nor are the existing noise levels at these locations, the alternatives can only be ranked in terms of potential noise impact by considering that the existing noise levels will increase with the size and level of activity of the local community. On this basis, Spences Bridge (which has two railways and Highway 1) would be the first choice, while Ashcroft (which has two railways and a very light industrial area) and Kelly Lake (which has one railway and a highway which has some ore trucking) would be less desireable sites. The larger number of residents likely to be exposed to project noise at Ashcroft are considered to make it the least favourable site.

(vi) 69 KV Transmission Line Construction

The construction of the 69 KV transmission lines will not contribute significantly to the noise impact of the project since where the line pass near residential areas (Thompson-Bonaparte confluence and south-west corner of Bonaparte Reserve 1), noise from other project activities (pumping station construction and coal preparation facility construction and overburden removal respectively) will be dominant. Helicopters are not planned for use in any of the transmission line construction.

6.3 STEAM LINE BLOW OUTS

Although construction noise YDNL's for plant, mine and offsites will be at their highest levels during the first year of construction, one significant noise will only occur during the last year of construction of each plant unit. This is the intermittent noise resulting from the blowing out of steam lines. Shortly before the commissioning of each unit, the steam lines will be blown out up to 10 times/day for a period of 1 to 2 weeks with each blow out lasting from 3 to 10 minutes.

The blowout lines will most likely emerge from the east wall of the boiler house so that receptors to the west will receive substantial shielding. On the west side of the plant, this blow out noise will not contribute significantly to the YDNL's established by the mine and plant operation except in the case of the blowing out of Unit No. 1 at which time (late 1983) no units will be yet operating. To the east of the plant, the unsilenced blow outs will increase the YDNL's significantly. In 1983, with no units yet operating, this increase will be about 10 dB above the level established by other plant construction activities. In subsequent years, with one, two and finally three units operating, the increments in project YDNL caused by blow-outs will decrease to from 4 to 2 dB due to the increasing level of plant continuous operating noise.

The major concern, however, is in regard to the peak intermittent noise levels produced by steam line blow outs. Since it is assumed that all blow outs will occur during the normal construction hours and hence not disturb sleep, the types of noise impact of concern are: startle of local people and animals and possible traumatic hearing loss or other injury to plant construction workers.

Because the shielding of the boiler house for blow outs to the east will be maximum towards the mine mouth area and will decrease gradually for locations south of the mine, the peak blow out noise levels will be fairly uniform at between 55 and 60 dBA for all Hat Creek Valley ranch houses. Over Bonaparte Reserve 1, these noise levels will range from about 60 dBA at the south end to 45 dBA at the north end. These intermittent noise levels will be from 5 to 15 dB above the quasi-continuous background noise levels established at local residences by other project activities and will, therefore, be clearly noticeable but will not be very startling.

Cattle or wild animals which were close to east side of the plant at the time of a blow out would be exposed to high noise levels capable of causing panic and injury [e.g. 100 dBA at about 900 m (3000 ft.) from the boiler house].

Blow out noise levels within the plant boundaries on the east side of the boiler house would be extremely high [140 dBA at about 30 m (100 ft.) from the steam line outlet]. The Worker's Compensation Board limit for even brief exposures to continuous noise is 115 dBA and this level would be exceeded at distances up to about 300 m (1000 ft.) from the outlet.

It is, therefore, apparent that, for the protection of construction workers and possibly animals, substantial silencing of steam blow out noise should be provided. The alternative of wearing hearing protection exists for the workers but obviously this would not benefit animals. (See Section 7.0).

6.4 MAXIMUM PROJECT NOISE IMPACT (FULL PLANT AND MINE OPERATION)

Because the Hat Creek Project will be comprised of many separate facilities of differing scale and location, in no one year will the noise levels associated with all of these facilities be at or near their maximum levels. In fact, for some of the offsite facilities (e.g. make-up water supply system and airstrip), the maximum noise levels will be generated during the first year of construction and hence were discussed in Section 6.2. Therefore, the period of maximum project noise impact will be based on the noise outputs of the two major facilities, the mine and power plant.

Once the fourth and final generating unit comes on line in 1987, the plant operation noise will have reached its maximum level (see Figure 4-1) and this level is assumed to be maintained until the units are decommissioned. Mining noise will not vary significantly from Stage 3 (1987-1993) when the plant reaches full capacity to Stage 7 (2018-2022) when the limit of the 180 m (600 ft.) deep pit is reached. However, a gradual increase in pit waste and superficials removal will result in maximum mining noise output during Stage 6 (2013-2018). Therefore, the maximum plant and mine noise impact has been considered to occur during the 5 year period of Mine Stage 6.

The operating noise levels of some offsite facilities will remain constant throughout the life of the project. For others, like the access road, there will be significant variations in noise levels with time. The maximum offsite operation noise impacts have, therefore, been computed in the year appropriate to each facility.

(a) Site and Environs

Total yearly average noise levels (YDNL's) around the plant and mine sites will be largely comprised of contributions from mine mobile equipment, coal preparation facilities and the plant (fans, plant walls and transformers) as well as a smaller contribution from pit blasting.

The impact of these operating noise levels will be discussed below for the various significant receptor regions. In arriving at the impact levels, it has been assumed that the receptors will not have been made less sensitive to project noise during Mine Stage 6 by exposure to project noise prior to Stage 6.

(i) Bonaparte Indian Reserve 1

Noise levels at the south-western end of Reserve 1 during Mine Stage 6 will be controlled by coal preparation and mine noise. Over the north-eastern half of the reserve plant fan noise will be controlling (assuming worst case fans are selected) except very near Highway 12 were project-related traffic will control the project noise level experienced. The variation of project noise levels over Reserve 1 is shown in Figure 6-10.

Environmental noise levels over Reserve 1 from 2013 to 2018 without the project will presumably still be controlled by Highway 12 traffic. Based on the predicted increase in non-project traffic noise levels from 1977 to 1991 of 2 dB [see Section 3.2 a (i)], the levels in 2013 will be approximately 5 dB higher than presently — barring any significant decrease in the inherent noisiness of motor vehicles over the intervening 35 year period. These future without-project noise levels are shown in Figure 6-11.

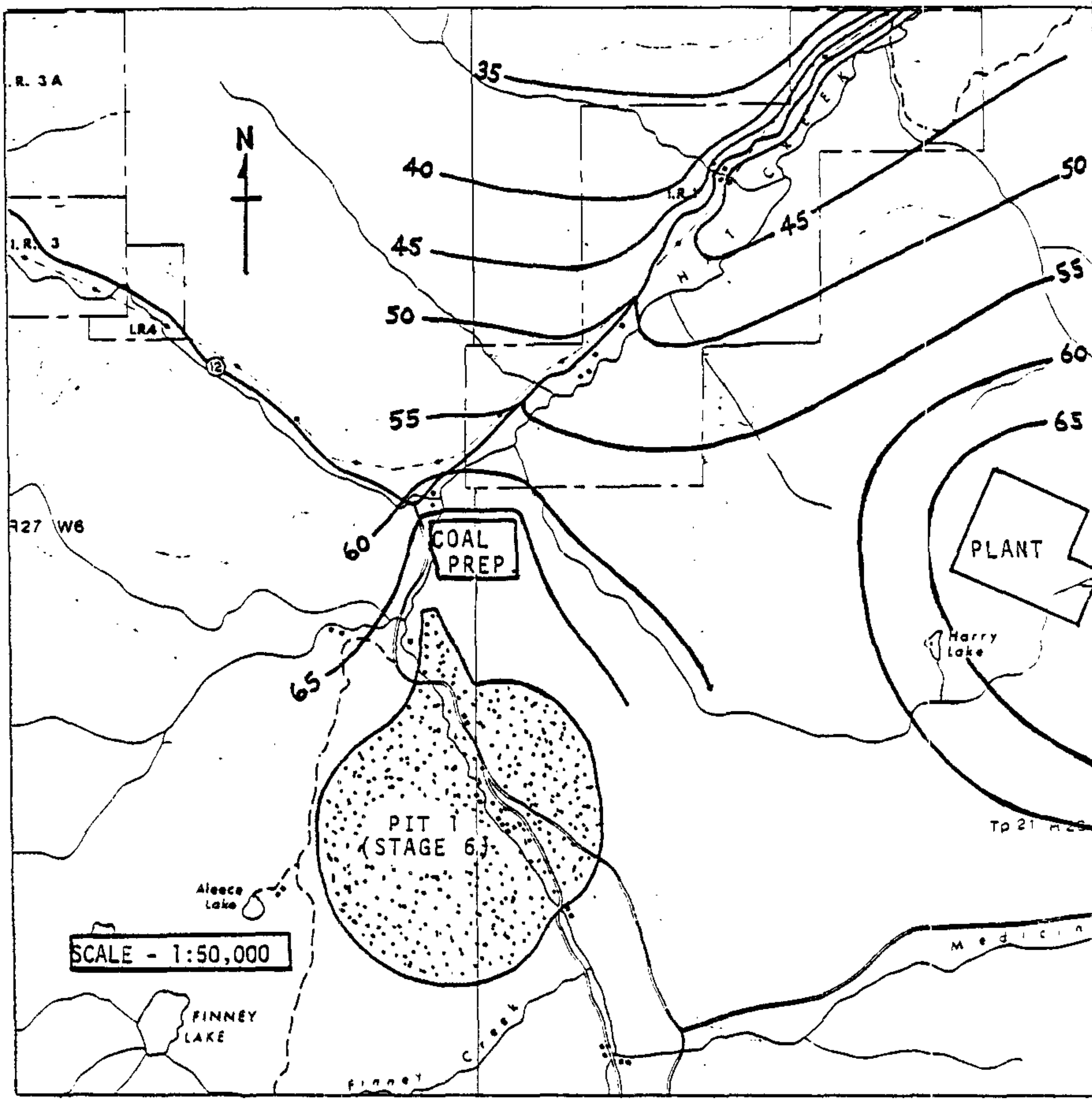

FIGURE 6-10: MINE AND PLANT OPERATION NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 DURING MINE STAGE 6 (2013-2018)

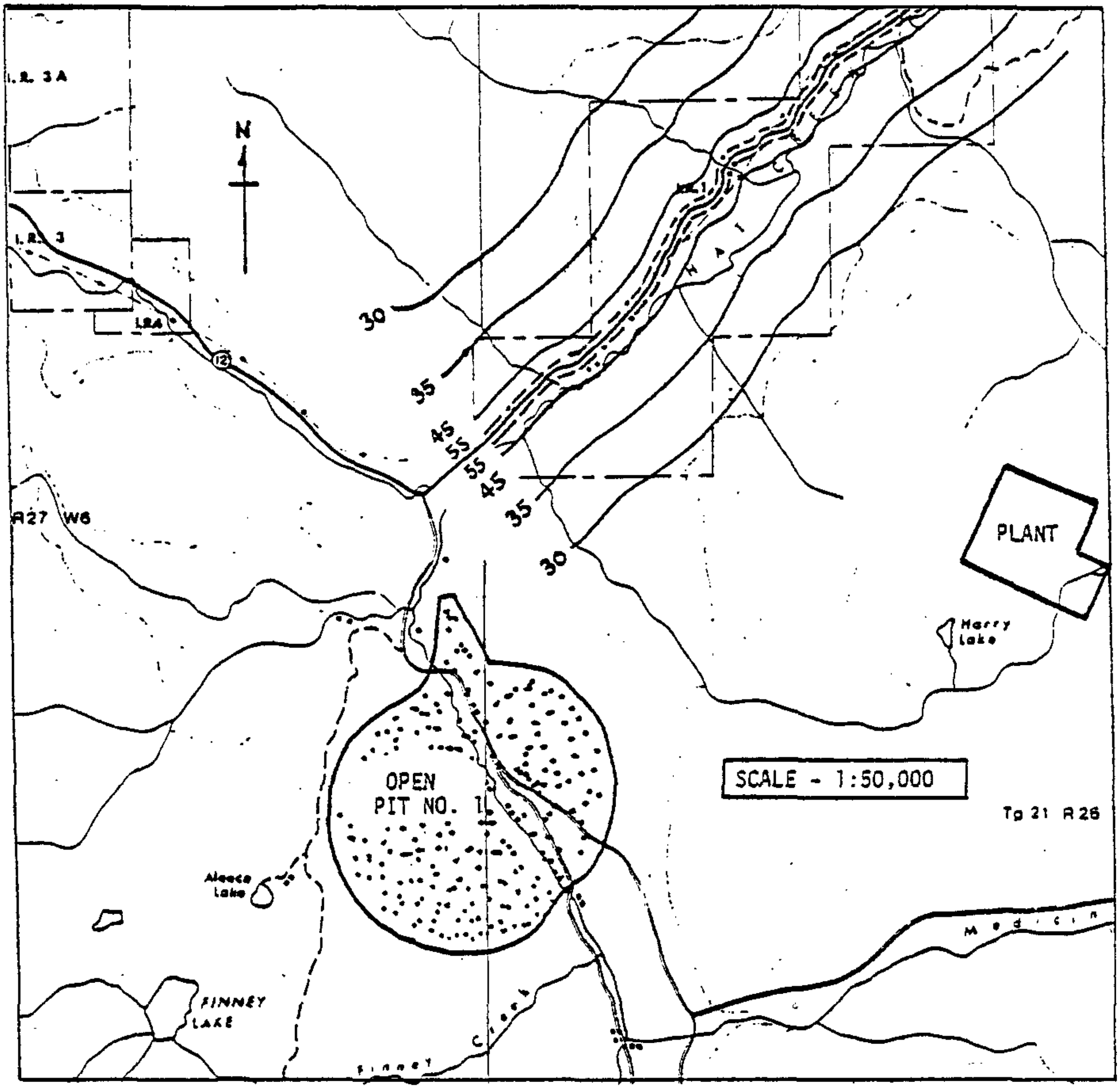

FIGURE 6-11: HIGHWAY 12 TRAFFIC NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 WITHOUT THE PROJECT DURING 2013.

Figure 6-12 shows the combined noise levels from project activities and local traffic. They are seen to vary from YDNL 62 at the south-western corner to YDNL 35 to 40 along the north-eastern edge of the reserve.

A. Land Use Incompatibility

Residential Land

The areas of Reserve 1 in which the combined noise levels during Mine Stage 6 will exceed YDNL 55 and hence will be considered incompatible with residential land use are shown hachured in Figure 6-12. The broad strip of land along the southern end of the reserve will be made incompatible by coal preparation and mine noise. This area presently contains only one occupied dwelling with four to six people. The strip of incompatible land along Highway 12 results from traffic noise and this is controlled by the predicted non-project traffic during Mine Stage 6. The locations of presently occupied dwellings on Reserve 1 are not known accurately enough to determine whether any are located within this strip of residentially incompatible land. However, if any are, their overall noise exposure will not be controlled by project activities.

Grazing Land

Since nowhere on Reserve 1 will the YDNL during Mine Stage 6 exceed 65, cattle grazing will everywhere be compatible.

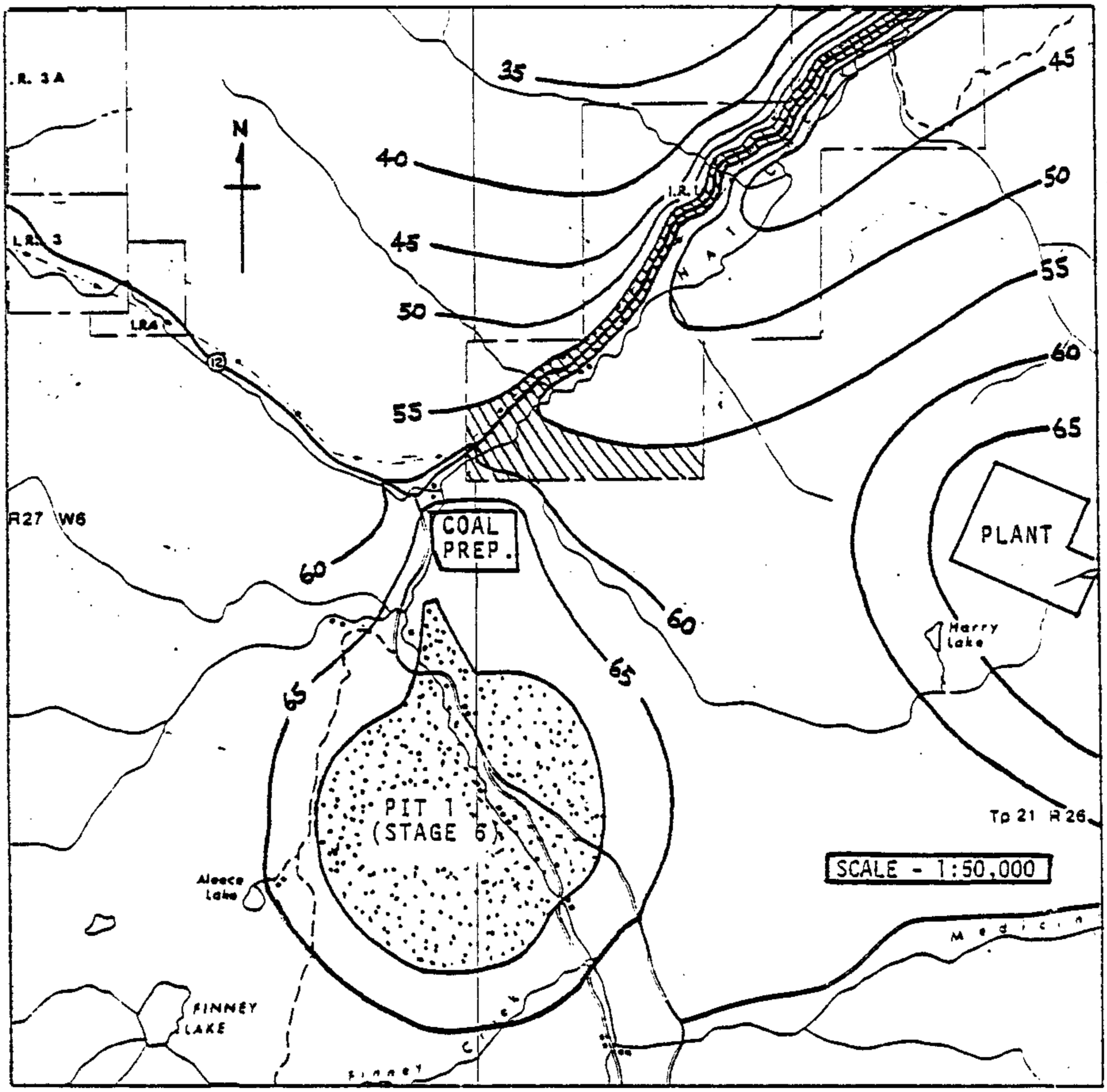

FIGURE 6-12: COMBINED, WITH-PROJECT NOISE LEVELS (YDNL CONTOURS) ON BONAPARTE RESERVE 1 DURING 2013. HACHURED AREA IS INCOMPATIBLE WITH RESIDENTIAL LAND USE.

B. Annoyance and Community Reaction

Average Noise Levels

Table 6-1 shows that, in areas where mine operation controls the project noise levels, a community sensitivity correction of +10 dB has been used in computing normalized project YDNL, whereas in areas where plant operation noise dominates, a +15 dB correction has been used. The reason for the higher correction for plant noise is the pure tone character of the dominant plant noise sources, notably fans and transformers. By applying these two corrections to the appropriate portions of Reserve 1 [as per Section 6.4 a (i) and Figure 6-10], it is seen that the normalized project YDNL's will vary from 72 to 50 dB from the southwest to northeast corners of the reserve. Figure 5-1 shows that the corresponding range of expected community reactions will be from threats of legal action to no reaction.

The combined noise levels (Figure 6-12) over the northern half of Reserve 1 and well away from Highway 12 will be controlled by induced draft fan noise from the plant. These noise levels apply to the worst case fans (noisiest of several manufacturers), so that by selecting much quieter fans or by providing adequate silencing, they could be reduced by from 5 to 6 dB. The achievement of greater noise reductions through fan treatment is prevented by the emergence of the coal preparation facilities and plant wall radiation as the dominant noise sources. Such plant noise reductions would not reduce the YDNLs at reserve dwellings since most are quite near the highway, however, the background noise level between traffic noise events would be reduced to close to the natural level over the northern half of the reserve. The residents nearer the more highly-impacted south end of the reserve would get no benefit from control of continuous plant noise so that the overall community reaction to the project noise might not be significantly changed by such measures.

Intermittent Noise Levels

Four types of intermittent operation noises are of concern on Reserve 1: mine pit blasting noise, plant electromatic valve and circuit breaker noises and mine public address system noise.

Mine pit blasting will take place once per day at the most frequent, and only during the day. Therefore, the impulsive blast noise, which will typically approach 118 dB (linear) assuming one blast per day) at the south-western corner of the reserve, is not expected to be a significant source of annoyance on Reserve 1 and will present no threat of hearing loss (see Table 5-1). However, the blast noise could be startling and should be preceded by much quieter but clearly audible warning signals.

The estimated frequency of the emergency venting of boiler steam to atmosphere through the electromatic valves is 4 per year per unit or a total of 16 per year at full plant operation. This frequency could temporarily increase if a particular unit became unbalanced. Since emergency ventings can occur at any time and typically last for 15 sec., the main concern here is sleep disturbance. With two valves opening simultaneously, as is normal, the peak noise levels at Reserve 1 residences will range from 59 dBA at the southern end to 50 at the north end. As discussed in Section 5.2 d, the criteria for sleep disturbance by intermittent noises are that the levels of noises outdoors should neither exceed the with-project YDNL by more than 20 dBA nor exceed 75 dBA. The lowest with-project YDNL at a Reserve 1 residence will be not less than 45 (see Figure 6-12) so that both the above criteria are met at all known residential locations. Hence, emergency steam venting is not expected to be a cause of annoyance at Reserve 1.

Like steam line blow outs, emergency steam venting will create very high noise levels at the plant site [e.g. 128 dBA at 30 m (100 ft.)]. Unlike line blow outs, emergency venting can occur without warning so that the danger to plant workers of traumatic hearing loss or other injury due to startle is greater. Therefore, substantial silencing of all vents and/or adequate hearing protection is felt to be necessary.

The impulsive noise of circuit breakers, if the worst case unsilenced, air-blast, pressurized-head units are installed, will have maximum peak levels of about 75 dBA (99 dB Linear) on Reserve 1. Circuit breaker noise at an average of 5 events/day will not contribute significantly to the YDNLs in the Hat Creek, although the individual events may be a source of annoyance, especially at night since the worst case noise level of 75 dBA equals the criterion established for intermittent nighttime noise events of 5 to 30 s duration. It will therefore be desirable to reduce circuit breaker noise levels somewhat from the worst case value both from the environmental noise and plant worker exposure view-points. See Section 7.1 f.

The public address system which will serve the mine and coal preparation areas could be a significant source of annoyance on Reserve 1, especially if a centralized speaker system was used. The system should be designed to restrict coverage to the project site and thus achieve the criterion of essential inaudibility at the reserve boundary as discussed in section 5. This could be achieved through use of a distributed, directional speaker system or a radio communication system or a combination of the two. See Section 7.0 for further discussion.

(ii) Bonaparte Indian Reserve 2

The increase in Highway 12 traffic noise due to project-associated traffic will be less during Mining Stage 6 than it will be during the first year of project construction due to the predicted 5 dB increase in non-project traffic noise in the interim. This increase in non-project traffic noise may mean that some residents on Reserve 2, if within 45 m (150 ft.) of the road, will be exposed to noise levels exceeding YDNL 55. The increment in traffic noise level due to the project however, will be less than 1 dB and, therefore, no significant impact is predicted.

(iii) Hat Creek Valley Ranches

As of March, 1978, there were seven occupied ranch houses in the Hat Creek Valley that will be within the range of audibility of the mine and plant. The most northern of these, the Ed Lehman residence, will be literally on the rim of the pit during Stage 6. This residence is considered to have been displaced by the project.

The remaining six houses are listed in Table 6-3 and their locations are shown in Figure 6-6. Table 6-3 also shows the without-project YDNL (assumed unchanged from present), the project YDNL, the combined with-project YDNL and the normalized project YDNL at each ranch house location. It is appreciated that during the 35 years from the present until Mine Stage 6, the numbers and distribution of Hat Creek Valley residents could change appreciably. But historically, the community has been very stable and as pointed out at the beginning of Section 6.4, mine and plant noise levels will be quite constant from 1987 to the end of the 35 year plant life. Therefore, the impacts predicted on the basis of the present population distribution are felt to be indicative of impacts that will occur in the future.

A. Land Use Incompatibility

<u>Residential Land</u>

The combined, with-project noise level at the two ranch houses closest to the mine will be YDNL 63 and hence these locations will be incompatible with residential land use. These two houses may be physically displaced by portions of the creek diversion facilities.

RANCH HOUSE	CURRENT (1978) OCCUPANT	DISTANCE FROM HIGHWAY 12 JUNCTION m (ft)	WITHOUT PROJECT YDNL	PROJECT YDNL	COMBINED WITH-PROJECT YDNL	NORMALIZED PROJECT YDNL (+15 dB)	EXPECTED RESIDENT REACTION
1	M. Saulte	4,900 (16,000)	35 - 40	63	63	78	Vigorous Action
2	Ike Lehman	4,900 (16,000)	35 - 40	63	63	78	Vigorous Action
3	A. Parke	8,540 (28,000)	35 - 40	49	49	64	Widespread Complaints
4	D. Ridlar (Baldwin)	9,760 (32,000)	35 - 40	45	45 - 46	60	Widespread Complaints
5	A. Pocock	13,400 (44,000)	35 - 40	36	39 - 42	56*	Sporadic Complaints
6	G. Parke	14,000 (46,000)	35 - 40	35	38 - 41	55*	No Reaction

*The higher community sensitivity correction of +20 dB has been applied at locations where plant noise (containing pure tones) is expected to be the dominant project noise.

TABLE 6 - 3: NOISE LEVELS AT HAT CREEK VALLEY RANCH HOUSES DURING MINE STAGE 6 AND EXPECTED REACTIONS OF THE RESIDENTS

Grazing Land

The region in the Hat Creek Valley over which the with-project YDNL will exceed YDNL 65 and hence be considered incompatible with grazing will extend for approximately 600 m (2000 ft.) beyond the rim of the pit during Stage 6. If it is considered that, without mining noise, grazing could be arried out right up to the active rime of the pit, then the area of grazing land alienated by noise alone will be roughly 6.5 $km.^2$ (2.5 square miles). This impacted area can be seen in Figure 6-12. In actuality, range fencing will be erected within 100 m (330 ft.) of the pit rim and will cordon off the areas between the pit and the two major waste dumps. Therefore, the area alienated from grazing by noise alone will be substantially less than stated above.

B. Annoyance and Community Reaction

Average Noise Levels

At the six presently occupied Hat Creek Valley ranch house locations which will be exposed to project noise, the expected annoyance reactions will range from vigorous action to no reaction (see Table 6-3).

Intermittent Noise Levels

Peak pit blasting noise levels (assuming one blast per day) will vary from about 122 dB (Linear) at the nearest ranch house (M. Saulte) to below 98 dBA at the most distant (G. Parks). These impulsive noise levels will not cause hearing loss (see Table 5-1) and because they will be produced only during the day, they will not be a source of sleep disturbance. However, they could be startling and should, therefore, be preceeded by much quieter, but readily audible warning signals.

Electromatic valve noise from the emergency venting of steam at the plant will produce intermittent (about 15 sec. duration) noise levels of from 60 dBA at the M. Saulte house to 35 dBA at the G. Parke house. Since the with-project YDNL's at these locations are 63 and 35 respectively, the steam venting noise will not be loud enough to cause sleep disturbance (see Section 5.2 d and Table 5-1).

(iv) Trachyte Hills

Assuming that the noisiest forced draft and primary air fans are installed in the plant, the area over which YDNL 65 will be exceeded and cattle grazing will then be incompatible, is roughly 4.0 $km.^2$ (1.6 square miles). This area is largely to the east of the plant and includes about 0.65 $km.^2$ (0.25 square mile) of the make-up water reservoir site (see Figure 6-12A). Since all of this area is above the 1200 m (4000 ft.) level, it is not prime grazing land* and the impact of the plant noise on the grazing capacity of the area is considered to be low.

The selection of quieter fans could reduce the area made incompatible with grazing dramatically.

(b) Offsite Facilities

(i) Make-up Cooling Water Supply System

The only potential sources of noise impact during the operation of the make-up cooling water supply system will be the two booster pumping stations.

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* The impacted area is judged by Canadian Bio Resources Consultants to provide spring range only, and of it, 10% has High grazing potential while 90% has low potential.

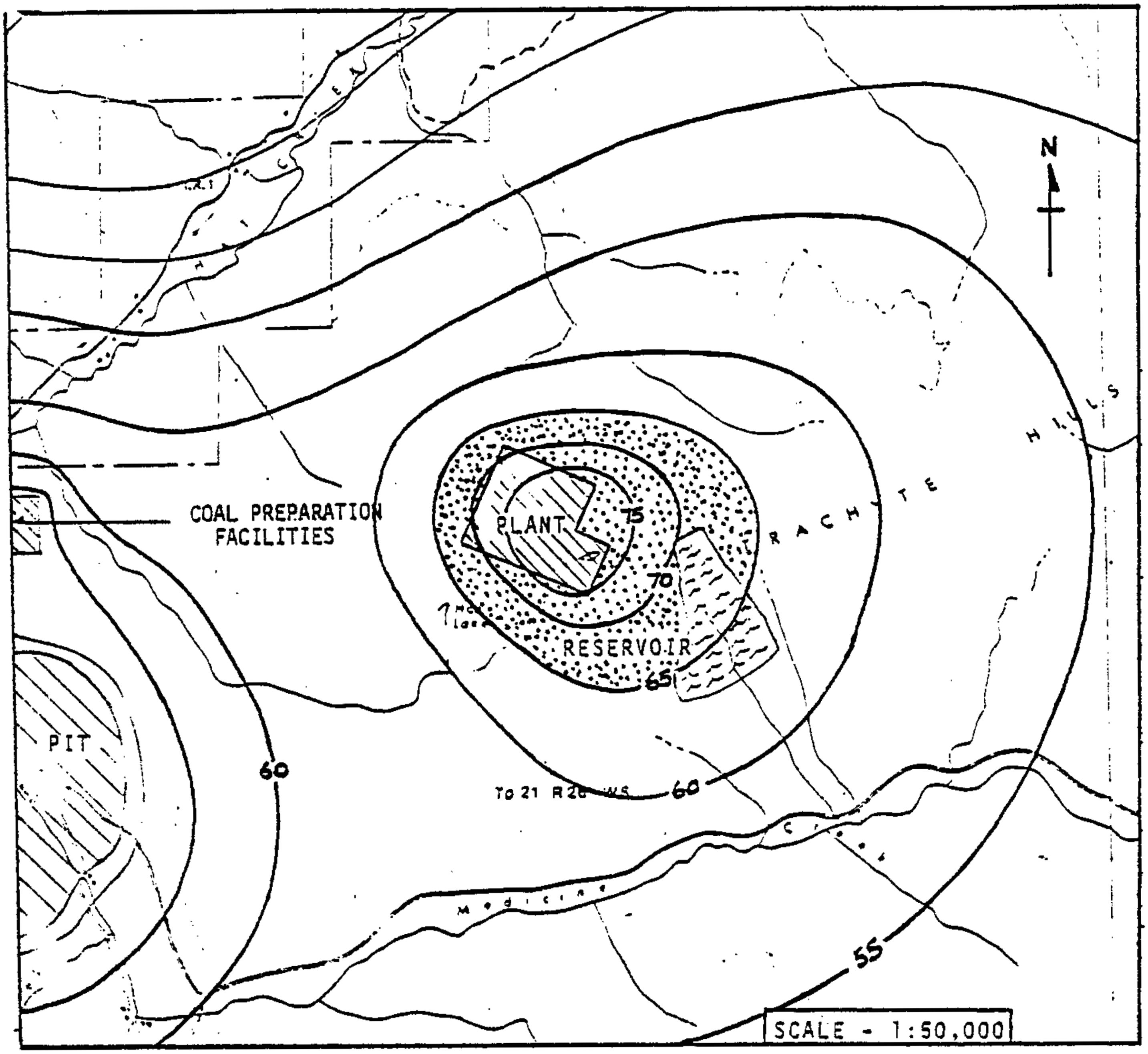

FIGURE 6-12A: PLANT OPERATION YDNL'S DURING MINE STAGE 6 SHOWING AREA INCOMPATIBLE WITH GRAZING LAND USE (YDNL >65) FOR WORST CASE FORCED-DRAFT AND PRIMARY-AIR FANS

A. Booster Pumping Station 1

Booster Pumping Station 1 will be located about 90 m (300 ft.) from the nearest residence in the small community at the Bonaparte-Thompson confluence (see Figure 6-7). When it is assumed that ventilation fans in each pumphouse end wall are unsilenced and are among the noisiest in their class (axial, 10 h.p.), the continuous operating noise levels will range from YDNL 66 at the south end to YDNL 56 at the north end of the community. If fan noise is reduced by, for example 25 dBA, through fan selection and silencing, the above range of noise levels would become YDNL 46 to 36 and would be controlled by transformer noise or fan noise depending on location.

Land Use Incompatibility

As Figure 6-7 shows, most of the primary residential area already has train-dominated noise levels incomaptible with residential land use (i.e. YDNL 62 to 55). With unsilenced, worst-case fans, the pumping station operation would increase these levels to from YDNL 67.5 to 59 and hence make the area considerably more incompatible. With adequate fan silencing, the increases in YDNL would be negligible but the pumping station noise would be clearly audible over most of the area during quiet periods between train events.

Annoyance and Community Reaction

The community sensitivity correction for intruding construction noise was established as 0 dB in Section 6.1 a (iii). However, fan and transformer noises will be permanent and have pure tone content so that, as shown in Table 6-1, it is necessary to increase the sensitivity correction to +10 dB. The range of normalized YDNLs for the unsilenced, worst-case fans will then be 76 to 66 and the expected range of community reaction will be from "vigorous community action" to "widespread complaints". If adequate fan noise reduction is carried out, the normalized YDNL's would instead be from 56 to 46 and the community reactions would range from "sporadic complaints" to "no reaction".

B. Booster Pumping Station 2

Land Use Incompatibility

In the event of unsilenced, worst-case fans, the limit of land use incompatibility with grazing (i.e. YDNL 65) would be a circle of about 120 m (400 ft.) radius centred on the pumphouse. This circle would include 5.0 ha. (12 acres) of which about 0.3 ha. (0.8 acres) will be taken up by the pumping station itself. Therefore, the area of grazing land alienated by noise would be about 4.7 ha. (11 acres).

If fan noise is reduced by 20 dBA, the incompatible area could be restricted to within 15 m (50 ft.) of the pumphouse walls so that the loss of grazing land would be insignificant.

(ii) Airstrip

Aircraft noise levels have been based on the traffic expected during the initial years of the project (a total of four take-offs and four landings per day; all during the daytime) since reliable forecasts cannot be made of traffic in the distance future. Take offs have been assumed to be into the prevailing winds, that is south at Site A and east at Site C.

A. Site A

Land Use Incompatibility

The noise "footprint"* of aircraft operations at Site A will extend through grazing and perhaps agricultural land but will not

* The noise footprint refers to that area over which aircraft noise levels (YDNL's) will equal or exceed the existing noise level, which is about L_{dn} 35 for Site A.

reach any populated areas. The compatible noise limits for grazing (YDNL 65) and agriculture [L_{eq}(24) 70] will not be exceeded beyond the cleared area of the airstrip itself. In order for the grazing limit of YDNL 65 to be exceeded for an appreciable distance in a narrow strip beyond the ends of the runway, say 1000 m (3300 ft.), the aircraft traffic volume would have to increase to roughly 700 movements per day. It is, therefore, concluded that light aircraft noise at Site A will have a negligible impact on grazing and agricultural land uses.

B. Site C

Figure 6-13 shows the noise footprint of light aircraft operations at Site C based on four take offs and four landings per day. Figure 6-14 shows the Highway 1 traffic noise levels around Site C based on predicted traffic volumes during Mining Stage 6 (2013)*. Figure 6-15 shows the combined road and aircraft traffic noise levels.

Land Use Incompatibility

Highway 1 traffic noise levels in 2013 will vary from YDNL 62 to 50 over the area occupied by the group of buildings about 300 m (1000 ft.) directly west of the airstrip (see Figure 6-14). With the airstrip in operation (eight movements/day) the combined noise levels would range from YDNL 62 to 53. Given the locations of buildings shown in Figure 6-14 (from B.C. Government Map, Ashcroft 92-1/11, 1973), no previously compatible location (i.e. YDNL $\leq$55) will be made incompatible by airstrip operation. If, however, buildings now exist at other locations, it is possible for a new incompatibility to occur, but the actual increase in YDNL involved would be less than 1 dB.

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* Traffic volumes for 2013 were obtained by direct extrapolation of growth trends predicted by Strong Hall & Associates for the period 1976 to 1991.

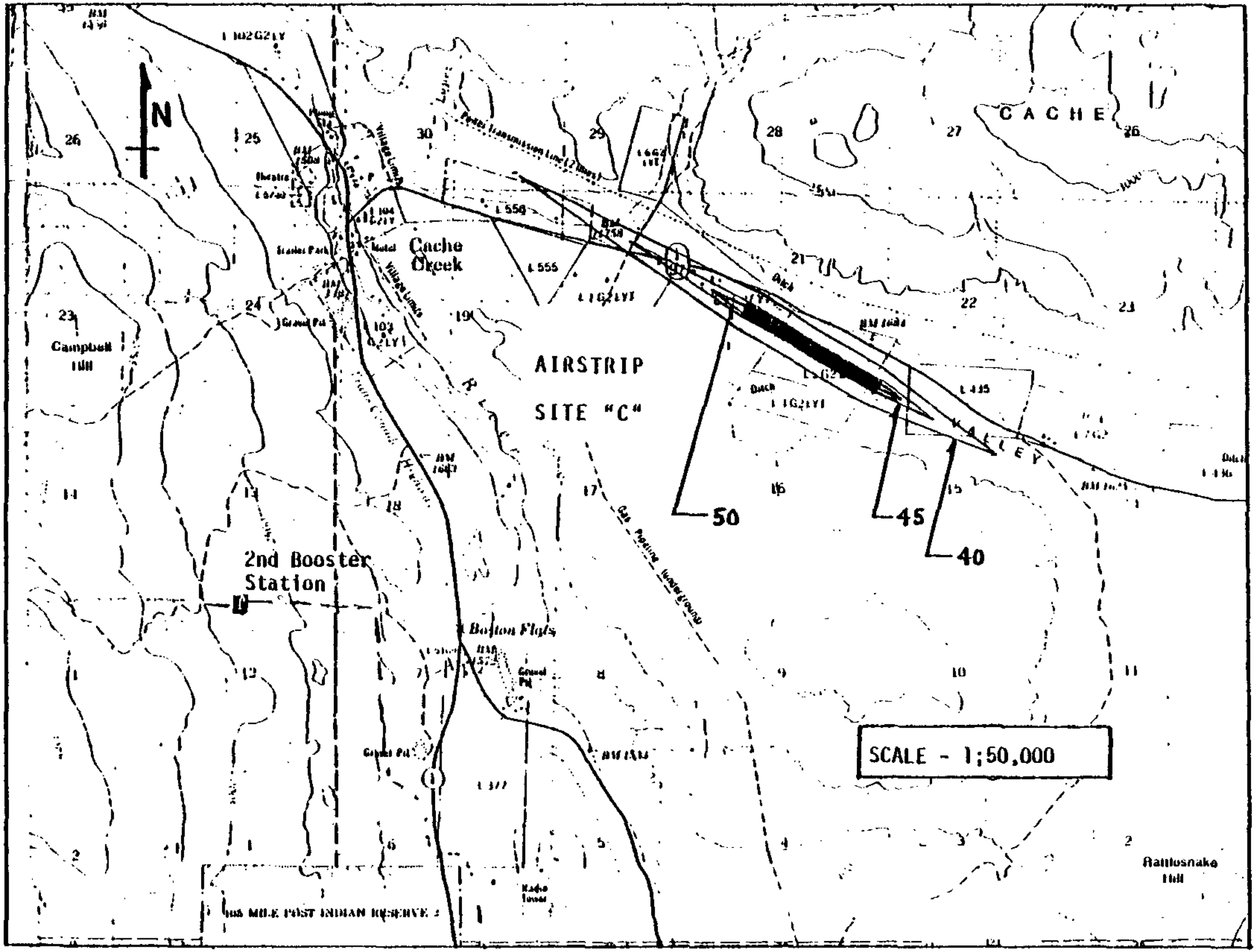

FIGURE 6-13 LIGHT AIRCRAFT NOISE "FOOTPRINT" (YDNL CONTOURS) AT AIRSTRIP SITE C; 8 AIRCRAFT MOVEMENTS/DAY, TAKEOFFS TO THE EAST.

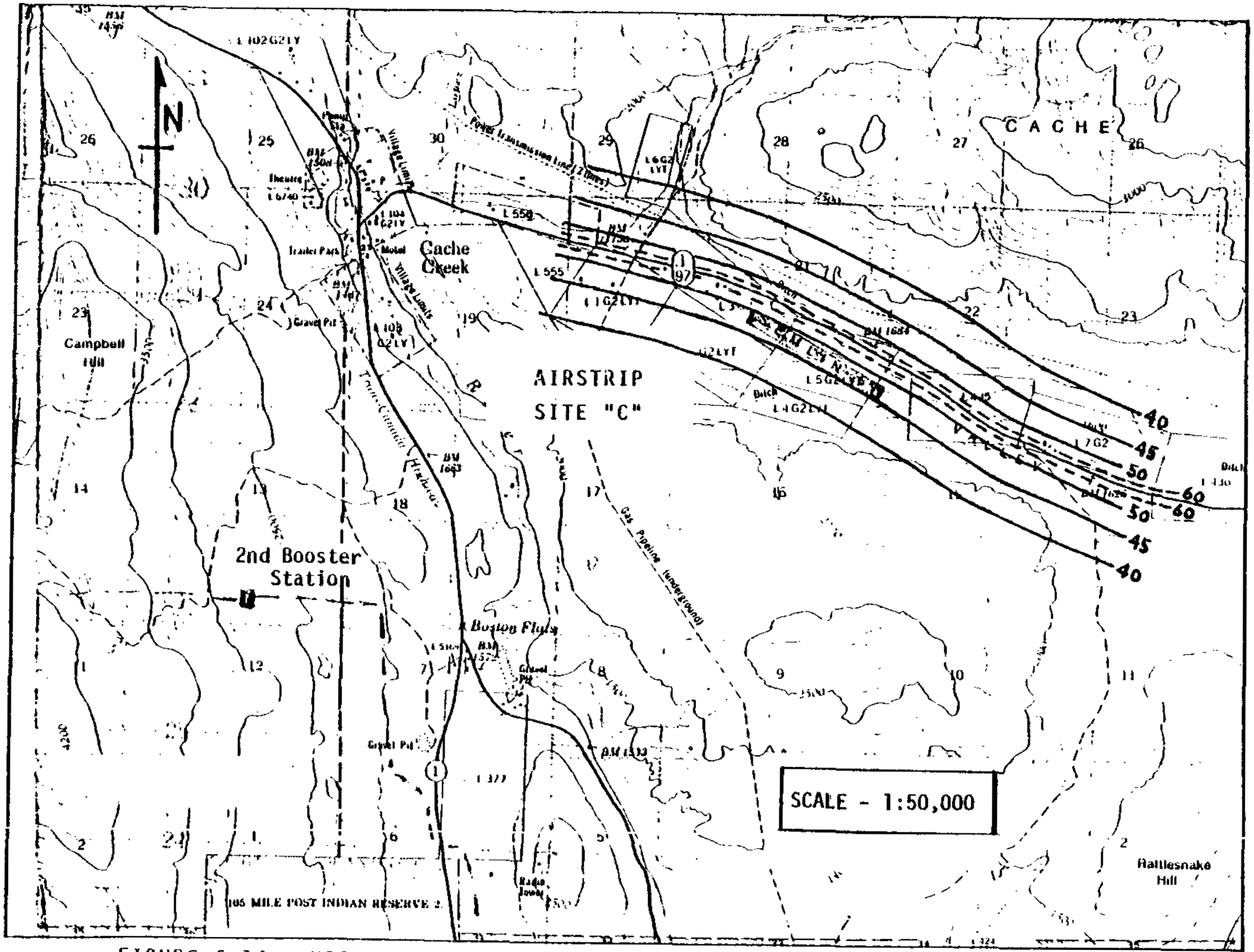

FIGURE 6-14: HIGHWAY 1 TRAFFIC NOISE LEVELS (YDNL CONTOURS) DURING 2013 (MINE STAGE 6) AT AIRSTRIP SITE C.

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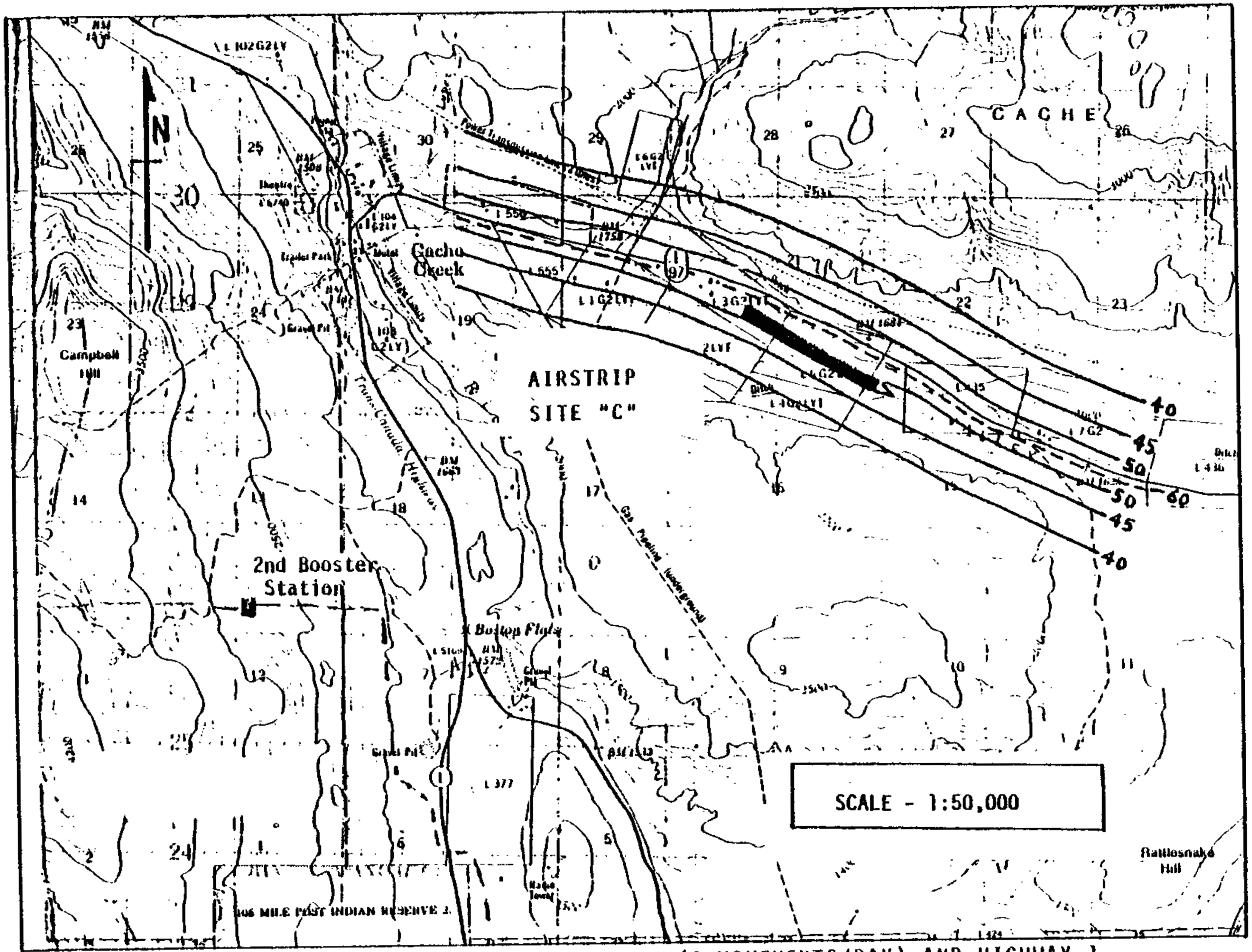

FIGURE 6-15: COMBINED LIGHT AIRCRAFT (8 MOVEMENTS/DAY) AND HIGHWAY 1 TRAFFIC NOISE LEVELS (YDNL CONTOURS) DURING 2013 (MINE STAGE 6)

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However, the actual increase in YDNL involved would be less than 2 dB and this is not considered sufficient to cause a significant change in the suitability of the area for residential land use.

Annoyance and Community Reaction

Adding the appropriate sensitivity correction of 0 dB (see Table 6-1) to the airstrip YDNLs of Figure 6-13, the normalized project YDNLs are seen to range from 40 to 50. Therefore, no significant reaction is expected from any residentis in the group of buildings to the west of the airstrip according to Figure 5-1. However, since the aircraft noise events, although few, will be very noticeable and could cause feelings of trepidation in some residents, the actual reaction will depend strongly on individual natures and the resident's opinions of the airstrip in general.

A fivefold increase in airstrip traffic would raise the expected community reaction range to include sporadic complaints.

(iii) Access Road

Peak access road traffic noise levels will not occur during Mine Stage 6 but rather during the peak construction years in the early 1980's. Therefore, 1983 has been chosen as the year to predict the impact of access road traffic noise. Project-associated traffic volumes were predicted by Strong Hall & Associates and local traffic volumes were again assumed to be 20% of the predicted traffic for Highway 12 [see Section 4.3 c (iii) B]. Traffic noise levels thus predicted for the section of road adjacent to the McLean Lake Indian Reserve are shown in Figure 6-16. Traffic speed was assumed to be 80 k.mh. (50 mph), mean road grade 5.3% and heavy truck mix 9.1% of total daytime traffic.

A. Land Use Incompatibility

McLean Lake Indian Reserve

As seen in Figure 6-16, at no point on the McLean Lake Reserve does the access road traffic YDNL exceed 65. Therefore, cattle grazing will remain compatible throughout the reserve.

Cornwall Hills

In the Cornwall Hills and other range country through which the access road will pass, the width of the strip along each side of the road within which YDNL 65 will be exceeded will vary from 9 m (30 ft.) to 6 m (20 ft.) depending upon road grade. Since these strips will barely extend beyond the shoulder of the road, the loss of grazing land due to traffic noise will be negligible.

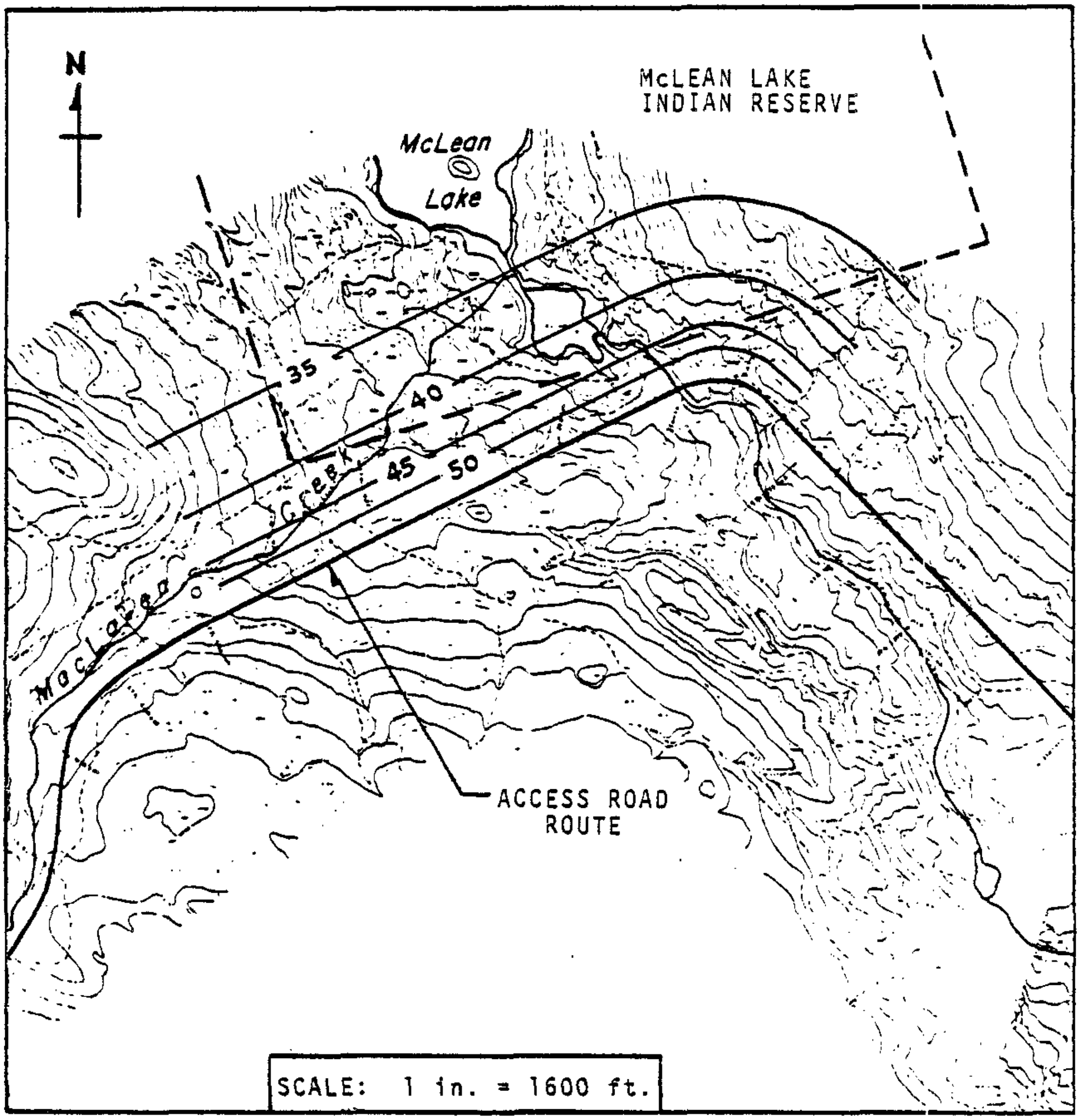

FIGURE 6-16: PEAK (1983) ACCESS ROAD TRAFFIC NOISE LEVELS (YDNL CONTOURS) ON THE McLEAN LAKE INDIAN RESERVE.

B. Annoyance and Community Reaction

The natural background noise level on the McLean Lake Indian Reserve is estimated to be between 30 and 40 dBA depending on nearby vegetation and water bodies and on weather conditions. Peak noise levels from trucks on the access road will vary between 70 and 53 dBA from the southern to the northern edges of the reserve. The intrusion of such noises may cause annoyance to persons involved in passive recreational activities on the reserve. Some of this noise impact may, however, be offset by the benefit of improved access to the reserve.

(iv) Creek Diversion Facilities

The operating noise of the creek diversion facilities will be limited to those created by a small pumphouse at the pit rim reservoir to be located about 300 m (1000 ft.) downstream of the confluence of the Medicine and Hat Creeks[101]. Since the pit rim reservoir will physically displace the two nearest, presently occupied residences , leaving more than 3.2 km. (2 miles) between it and the next nearest ranch house, no noise impact is anticipated.

(v) Equipment Offloading Facilities

A. Ashcroft Site

The noise impact due to the operation of the offloading facilities will be primarily due to the daytime movements of semi-trailer trucks through the adjacent community to and from the main Highway. In this regard, the most noise-sensitive situation is felt to exist at the North Ashcroft (CNR) site since the initial trucking route would likely be along the old highway (now a side street) past residential areas, parks and a school (see Figure 6-3). At the borders of these noise receptors areas, about 15 m (50 ft.) from the old highway centreline, the trucking noise levels, assuming 20 movements per day, will be from YDNL 51 to 55 depending on road grade.

Land Use Incompatibility

The offloading facility will be used predominantly during the project construction phase from 1980 to 1987, although it will see infrequent later use during project maintenance. Therefore, the facility is regarded as permanent noise source.

The existing noise levels along the trucking route are estimated at from YDNL 50 to 55 and are not expected to increase much in the near future without the project. Combined with-project noise levels along the trucking route will then range from YDNL 54 to 58. Therefore, most of the houses bordering directly on the old highway would be exposed to incompatible levels of noise. The actual increases in YDNL due to the trucking would be from 1 to 6 dB.

Annoyance and Community Reaction

The community sensitivity correction for the residential area will vary from 0 to +5 dB so that the normalized project YDNLs along the trucking route will be from 51 to 60. The community reaction is, therefore, expected to vary from widespread complaints to no reaction.

The Ashcroft village clerk feels that a truck route will, in the future be designated to run parallel to the CNR line from the industrial zone to the Ashcroft-Cache Creek Highway. A probable route would be along Government St., through an older residential area. This route is shorter and over a more level grade, hence the impact of trucking will be considerably less. (see Figure 6-3).

B. Kelly Lake and Spences Bridge Sites

The precise locations of the offloading sites at Kelly Lake (BCR) and Spences Bridge (CPR) are not known, but the potential for noise impact at these sites is felt to be less than at the Ashcroft site. Kelly Lake is a small community located on the road between Clinton and Pavilion which already sees, fairly heavy use by ore trucks. The number of people exposed to project noise at Kelly Lake would likely be small compared to that at Ashcroft. Spences Bridge is located on Highway 1 and on both CPR and CNR mainlines. Therefore, the trucking route from the CPR offloading site to Highway 1 would be short and the existing noise levels are high.

(vi) 69 KV Transmission Line

The only significant sources of noise associated with the operation of the 69 KV transmission line will be the various transformers. Transformer noise from the Rattlesnake Substation on the existing 230 KV transmission line and the plant and mine construction substations will be addressed here. The transformers at the booster pumping stations were covered in Section (i) above as part of the make-up cooling water supply system.

A. Rattlesnake Substation

This substation will be built independently of the Hat Creek Project. Two possible sites have been selected on the hillside northeast of Cache Creek. The nearest existing (and probable future) residences are about 1.5 km. (0.6 miles) from these sites. The noise level from the two transformers (150 MVA) at that distance will be YDNL 40. Noise levels at the location of the nearest residents (Sunvalley Subdivision) were measured in 1975 as part of another study[102] and found to be L_{dn} 55 to 60 (due largely to trucking noise from Highways 97 and 1). Therefore, transformer noise will not significantly increase the community noise levels. If a community sensitivity correction of +10 dB (+5 dB for no prior exposure and +5 dB for pure tone content) is added to the predicted transformer YDNL, the normalized YDNL becomes 50. Therefore, no community reaction is anticipated.

B. Mine Substation

Mine substation transformer noise will only be noticeable at night during the construction years when other mine activities are expected to be shut down. During these years, two 20 MVA, 69 KV/12 KV transformers will be used at the mine. At the nearest boundary of Bonaparte Indian Reserve 1, these units will createa noise level of YDNL 41*. This yearly average level is insignificant compared to those of other mine and mine mouth activities (YDNL 62 at boundary; see Figure 6-5). However, at night the background noise

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* Based on a conservative estimate by B.C. Hydro of the noise output of the "used" transformers to be initially installed at the mine.

level, assuming the rest of the mine site is quiet, will reach 30 to 33 dBA. Therefore, the transformers, which will generate a steady noise level of 34 dBA at the reservation boundary, will be clearly audible outdoors during quiet periods; their audibility being enhanced by the pure tone content of their noise. Therefore, noise shielding should be provided on the north side of these transformers.

C. Plant Construction Substation

The plant construction substation transformers will not be audible at Reserve 1, however, they will control the nighttime noise level at the construction camp [about 150 m (500 ft.) away] prior to the start up of the first generating unit. This level will be 45 dBA outdoors or about 31 dBA indoors. Although this noise will be audible, it will not likely be found annoying or cause sleep disturbance to the camp residents.

6.5 NOISE IMPACT DURING LAST YEAR OF PROJECT

As was stated in the introduction to Section 6.4, the operating noise levels of the plant and mine will not change significantly from the time the fourth generating unit comes on line until the decommissioning of the plant. A significant change in this context is one which would result in a discernable change in the impact of noise on receptors, either in terms of land use incompatibility or expressed annoyance.

A minimum change in with-project YDNL of from 3 to 5 dB would generally be required to be noticeable and to cause a shift in impact. Changes of this order will not occur between the time of worst project impact (Mine Stage 6) and the last year of the project. Therefore, last year noise impact has not been calculated and is considered to be the same as predicted in Section 6.4 for Mine Stage 6.

6.6 DECOMMISSIONING NOISE IMPACT

(a) Mine Reclamation

(i) Pit Reclamation

Section 4.4 described how, based on the limited data available regarding decommissioning procedures, estimates were made of the scale of mine reclamation work relative to mining itself. It was concluded that the noise levels created by the active reclamation work (recontouring of pit slopes) would be roughly 20 dBA below those created by mining. Therefore, not only would the reclamation work be quiet by comparison to the prior mine operation, in absolute terms, its noise impact on Bonaparte Reserve 1 and the Hat Creek Valley ranch houses would be insignificant.

(ii) Dump Reclamation

The reclamation of waste dumps (recontouring, covering with topsoil and revegetating) is expected to be complete by the time mining activity ends. Therefore, this reclamation will have no significant noise impact of its own since mine and coal preparation facility noise will control the total levels generated [see Section 4.3 b(ii) A].

(b) Plant Decommissioning

Not enough information is available about the procedures and equipment to be involved in the demolition of the plant to allow the quantitative evaluation of the noise impact of the process.

In general terms, Integ-Ebasco envisages the following activities:

1. Equipment and steel work will be salvaged.
2. Stack, cooling towers (if concrete) and turbine foundations will be blasted and the concrete buried.
3. The plant reservoir will be left as a lake.
4. The ash pond will be allowed to dry through evaporation (this may take many years) and then will be covered with topsoil and reseeded.

Although nothing of a quantitative nature can be now said about the noise levels to be produced by plant decommissioning, some comments can be made about the timeframe of the work. The plant demolition is expected to take about one year compared to eight years for its construction. As with construction but unlike plant operation, decommissioning work will be conducted only during the daytime.

(c) Decommissioning of Offsites

As with the plant, no detailed plans have yet been made for the decommissioning of the offsites. The access road and the airstrip, however, will remain in service under the jurisdictions of the Provincial Department of Highways and the local authorities respectively. In all other cases, the noise impact of offsites decommissioning is expected to be substantially less than that of their construction. The tentative plans for those offsites which will be decommissioned are:

(i) Make-up Water Pipeline

The pipeline will not be worth salvaging after 35 years of use. Therefore, it will be left in the ground.

(ii) Booster Pumping Stations

The precast concrete buildings will be dismantled and the equipment salvaged without blasting. The foundations will likely be left. However, if for land-use reasons the foundation of pumping station 1 is removed, it would be done by jackhammers rather than blasting. Therefore, this would create a short-term (one week) annoyance for residents at the Thompson-Bonaparte Confluence, but would not be significant in terms of YDNL.

(iii) Make-Up Water Intake

The superstructure of the water intake will be dismantled and the equipment removed. The concrete pier will be left in the river as blasting will not be permitted underwater.

(iv) Creek Diversion Facilities

The diversion canal would be left in place. If the mine pit is to be allowed to become a lake, a short, controlled diversion canal would have to be constructed from the canal headworks to the pit rim.

(v) 69 kV Transmission Line

Those transmission lines serving the mine, plant and booster pumping stations would be dismantled and removed.

(vi) Access Road Traffic

During plant decommissioning, truck traffic on the access road will likely approach the levels predicted for peak construction years. Passenger car traffic, will also likely increase over its plant-operation levels, however, it will not reach the levels predicted for the construction years.

(vii) Offloading Facilities

The crane will be dismantled. Depending on tne desires of the CNR, the spur line and fencing will either be left or removed. Some grading and site restoration will be done.

6.7 DISCUSSION AND SUMMARY OF PROJECT NOISE IMPACTS

In this section, the peak construction (1878-79) and peak operation [Mine Stage 6 (2013-3018)] noise impacts, identified in Sections 6.2 and 6.4 respectively, have been summarized in tabular (matrix) form. For each receptor location-noise source pair, the level(s) of impact(s) have been indicated and an overall noise impact significance category assigned. The impact significance categories parallel those specified for use in the impact matrices contained in Appendix F. The rationale for the assignment of impact significance categories is discussed below.

(a) Noise Impacts on Residential Areas

No project environmental noise levels at present or probable future residential areas will exceed the criteria for severe health effects (hearing loss, etc.) of L_{eq}(24) 70 for permanent noise sources. Therefore, the residential noise impact concerns are restricted to land use incompatibility and simple annoyance resulting in adverse community reaction.

(i) Land Use Incompatibility

The residential land use compatibility criterion of YDNL 55 is based on the desire to protect the public health and welfare through the avoidance of significant interference with human activities like speech communication, thought and sleep. The degree of interference with activities (primarily speech and sleep) can be related directly to the level of intruding noise. Therefore, an absolute noise level threshold for significant interference, and hence impact, can be identified which can be expected to apply to all residential areas. This level has been herein established as YDNL 55. Below this noise level threshold no significant negative health and welfare effects are expected. Above this level, negative effects will increase steadily with the degree to which the noise interferes with human activities.

Since speech interference has been identified as the primary interference of noise with human activities[103] and is the foundation of the YDNL 55 criterion*, it has been selected as the primary basis of the impact significance categories to be used herein.

The effects on humans of outdoor noise environments of YDNL 55, 65 and 75 have been summarized[104] and appear as Tables 6-4, 5 and 6 respectively. It is seen by comparing the comments regarding indoor and outdoor speech intelligibility in Tables 6-4, 5 and 6 that the degradation of intelligibility with increasing noise level is more pronounced outdoors than indoors, i.e., indoors the speech disturbance increases from "none" to "slight" to "some" while outdoors, it increases from "slight" to "significant" to "very significant". This is because the masking effect of noise remains quite small until the noise level reaches the level of the human voice and then it increases rapidly[105], as shown in Figure 6-17.

In the development of a scale of the significance of noise impact on residential land use (see Table 6-7), the above comments regarding speech intelligibility have been drawn upon directly. That is, the onset of significant impact has been considered to occur at a noise level of YDNL 56 (1 dB above the level corresponding to 100%

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* The 10 dB nighttime weighting factor applied in the calculation of L_{dn} or YDNL provides an inherent restriction on nighttime noise which could cause sleep disturbance.

TYPE OF EFFECTS	MAGNITUDE OF EFFECT
Speech - Indoors	No disturbance of speech 100% sentence intelligibly (average) with a 5 dB margin of safety
- Outdoors	Slight disturbance of speech with: 100% sentence intelligibility (average) at 0.35 meter or 99% sentence intelligibility (average at 1.0 meter or 95% sentence intelligibility (average) at 3.5 meters
Average Community Reaction	None; 7 dB below level of significant "Complaints and threats of legal action" and at least 16 dB below "vigorous action" (attitudes and other non-acoustical factors may modify this effect)
High Annoyance	Depending on attitude and other non-acoustical factors, approximately 5% of the population will be highly annoyed.
Attitudes Towards Area	Noise essentially the least important of various factors

TABLE 6-4: SUMMARY OF HUMAN EFFECTS FOR OUTDOOR DAY-NIGHT AVERAGE SOUND LEVEL OF 55 DECIBELS.

Source: Reference No. 104

TYPE OF EFFECTS	MAGNITUDE OF EFFECT
Speech - Indoors	Slight disturbance of speech. 99% sentence intelligibility (average) with a 4 dB margin of safety
- Outdoors	Significant disturbance of speech with 100% sentence intelligibility (Average) at 0.1 meter or 99% sentence intelligibility (average) at 0.35 meter or 95% sentence intelligibility (average) at 1.2 meters
Average Community Reaction	Significant; 3 dB above level of significant "complaints and threats of legal action" but at least 7 dB below "vigorous action" (attitudes and other non-acoustical factors may modify this effect).
High Annoyance	Depending on attitude and other non-acoustical factors, approximately 15 percent of the population will be highly annoyed.
Attitudes Towards Area	Noise is one of the most important adverse aspects of the community

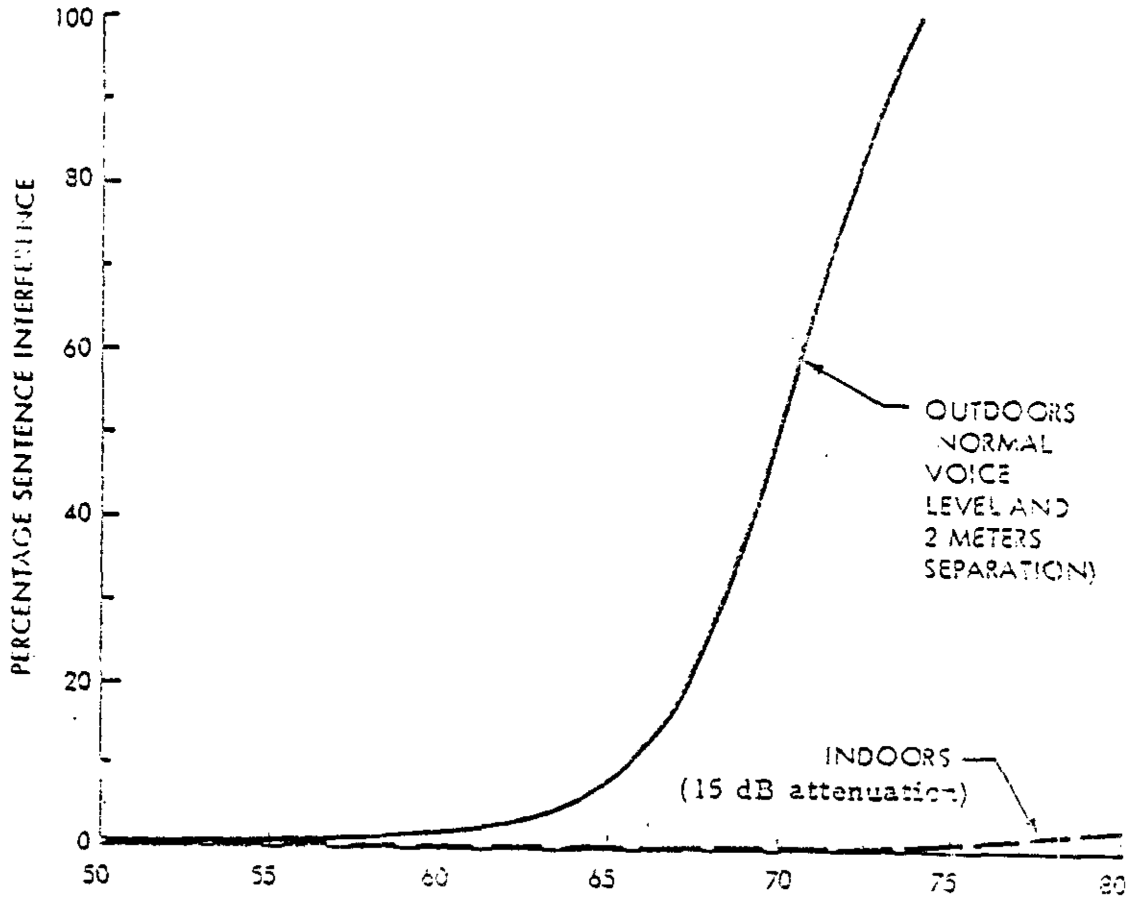
TABLE 6-5: SUMMARY OF HUMAN EFFECTS FOR OUTDOOR DAY-NIGHT AVERAGE SOUND LEVEL OF 65 DECIBELS.

Source: Reference No. 104

TYPE OF EFFECTS	MAGNITUDE OF EFFECT
Speech - Indoors	Some disturbance of speech Sentence intelligibility (average) less than 99%
- Outdoors	Very significant disturbance of speech with: 100% sentence intelligibility not possible at any distance or 99% sentence intelligibility (average) at 0.1 meter or 95% sentence intelligibility (average) at 0.35 meter
Average Community Reaction	Very severe; 13 dB above level of significant "complaints and threats of legal action" and at least 3 dB above "virgorous action" (attitudes and other non-acoustical factors may modify this effect)
High Annoyance	Depending on attitude and other non-acoustical factors, approximately 37% of the population will be highly annoyed.
Attitudes Towards Area	Noise is likely to be the most important of all adverse aspects of the community

TABLE 6-6: SUMMARY OF HUMAN EFFECTS FOR OUTDOOR DAY-NIGHT AVERAGE SOUND LEVEL OF 75 DECIBELS

Source: Reference No. 104



OUTDOOR DAY NIGHT AVERAGE SOUND LEVEL, L_{dn}, IN DECIBELS (re 20 micropascals)

Note: Percentage interference equals 100 minus percentage intelligibility, and L_{dn} is based on L_d +3.

FIGURE 6-17: MAXIMUM PERCENTAGE INTERFERENCE WITH SENTENCES AS A FUNCTION OF THE DAY-NIGHT AVERAGE NOISE LEVEL.

Source: Reference 79

indoor intelligibility). The onset of "extreme" noise impact has been taken to be slightly (1 dB) below the noise level at which "very significant" disturbance of outdoor speech occurs (see Table 6-6). The other three impact significant categories — low, moderate and high — are distributed between these limits in a manner that reflects the non-linear increase of speech disturbance with rising noise level (each new category represents roughly a fivefold increase in the percentage of unintelligible sentences).

In terms of interference with human activities, it makes little difference whether the intruding noise is due to existing road or rail traffic or due to the project. However, in the interest of evaluating the impacts of the project explicitly, a differentiation must be made between those residential areas in which existing environmental noise levels are compatible (i.e. ≤ YDNL 55), and those in which they are incompatible. Table 6-7 can only be applied directly to those areas which are presently compatible.

For the presently incompatible residential areas, the crucial index in the evaluation of project impact significance is not the combined YDNL itself but the increase in YDNL caused by the project. Unfortunately, the difference between combined and existing YDNLs cannot be used directly as the required index because of the non-linearity of speech disturbance with noise level (e.g. a 2 dB increase at the bottom of the scale of Table 6-7 is not as significant as at the top). Hence, a logical, if somewhat arbitrary, technique has been developed to attach significance to increases in YDNL due to the project. It is based on the shift in impact significance category which is caused by the intruding project noise and is depicted in Table 6-8. For example, if the existing YDNL at a residential location was YDNL 61, then the existing impact significance category would, according to Table 6-7 be "Low". If a project activity increased the environmental noise level to YDNL 71, the impact significance of

OUTDOOR COMBINED (WITH-PROJECT) YDNL	LEVEL OF SPEECH DISTURBANCE*	SIGNIFICANCE OF PROJECT NOISE IMPACT
	<u>At YDNL 75</u>	
> 73	- Some indoor speech disturbance; A.S.I.** less than 99% - Very significant outdoor speech disturbance; 100% A.S.I. not possible at any distance	Extreme
70 to 73		High
	<u>At YDNL 65</u>	
64 to 69	- Slight indoor speech disturbance; 99% A.S.I. with 4 dB safety margin - Significant outdoor speech disturbance. 100% A.S.I. at 0.1 m (0.33 ft.)	Moderate
56 to 63		Low
	<u>At YDNL 55</u>	
≤55	- No speech disturbance indoors; 100% A.S.I. with 5 dB Safety Margin - Slight speech disturbance outdoors; 100% A.S.I. at 0.35 m (1.15 ft.)	Insignificant

* Reference 5

** A.S.I. means Average Sentence Intelligibility

TABLE 6-7: SIGNIFICANCE OF THE IMPACT OF PROJECT NOISE ON PUBLIC HEALTH AND WELFARE IN RESIDENTIAL AREAS HAVING EXISTING YDNL ≤55

COMBINED NOISE IMPACT SIGNIFICANCE*

EXISTING NOISE IMPACT SIGNIFICANCE*

	INSIGNIFICANT	LOW	MODERATE	HIGH	EXTREME
EXTREME	--	--	--	--	MODERATE
HIGH	--	--	--	MODERATE	HIGH
MODERATE	--	--	LOW	MODERATE	HIGH
LOW	--	LOW	MODERATE	HIGH	EXTREME
INSIGNIFICANT	INSIGNIFICANT	LOW	MODERATE	HIGH	EXTREME

- The existing and Combined Impact Signifiances are obtained by entering the corresponding YDNL's in Table 6-7.

  Note: The table only applies when there is a positive increment in YDNL due to the project.

TABLE 6-8: THE SIGNIFICANCE OF INCREASES IN YDNL DUE TO PROJECT NOISE AT RESIDENTIAL LOCATIONS HAVING EXISTING YDNL's >55 the combined noise level would become "High". Therefore, by entering the matrix of Table 6-8 at "Low" existing impact significance and at "High" combined impact significance, it is seen that the actual impact significance of the project noise is "Moderate".

(ii) Community Reaction

A scale of noise impact significance has also been established for the negative community reactions expected to result from the various levels of normalized project YDNL which were discussed in Section 5.2 c and depicted in Figure 5-1. This scale was developed directly from the range of community reactions of Figure 5-1 and is shown in Table 6-9. The "Insignificant" impact category corresponds to those levels of normalized project YDNL which would be generally noticeable but would elicit no public reaction. The "Extreme" impact category applies when vigorous community reaction is expected.

There is some overlap of the ranges of normalized project YDNL over which the various degrees of public reaction are expected to occur. However, to facilitate the assigning of noise impact significance, these ranges have been conservatively modified so that they are consecutive. The range of YDNL's encompassed by each impact significance category begins at the lowest YDNL value of the group of data points in each corresponding community reaction category of Figure 5-1.

NORMALIZED YDNL OF INTRUDING NOISE*	COMMUNITY REACTION TO THE INTRUDING NOISE	NOISE IMPACT SIGNIFICANCE
≥ 76	Vigorous Community Action	Extreme
68 - 75	Threats of Legal Action or Strong Appeals to Stop Noise	High
60 - 67	Widespread Complaints or Single Threat of Legal Action	Moderate
56 - 59	Sporadic Complaints	Low
≤ 55	No Reaction, Although Noise Generally Noticeable	Insignificant

• Normalized to residential urban residual (existing) noise, some prior exposure and no pure tone or impulse content.

TABLE 6-9 : SIGNIFICANCE OF IMPACT DUE TO THE NORMALIZED YDNL's OF INTRUDING PROJECT NOISE

(iii) Overall Noise Impact in Residential Areas

Together, Tables 6-7, 8 and 9 allow the significance of the impact of intruding noise in residential areas to be evaluated under all circumstances, that is, with all combinations of existing and with-project noise levels:

1. In cases where residential land use remains compatible only Table 6-9 is used to determine impact significance,
2. When residential land use becomes or already was incompatible, both types of impact are evaluated and the more significant impact is adopted.

The above procedure has been used to evaluate the noise impact significance at all impacted residential areas in the study region. This information is summarized in Tables 6-10 and 6-11. Where the existing or project noise levels vary significantly over a residential area, a range of impact significance has been given. In arriving at the overall impact significance for each residential area in Tables 6-10 and 6-11, however, a single significance category has been selected which is most representative of the range of significance for the more severe of the health and welfare and community reaction types of impact.

(b) Noise Impacts on Other Land Uses

(i) Grazing

The only significant noise impact on grazing land use will occur around the perimeter of the pit and coal preparation area. Plant operating noise levels, particularly to the east of the property line, will to a greater or lesser extent depending on equipment selection, exceed YDNL 65. However, the surrounding land provides only spring range and only 10% of it is considered to be of high quality, the remainder low. Therefore, the impact of plant noise on local grazing capacity is considered to be low.

RESIDENTIAL LOCATION		EXISTING YDNL	COMMUNITY SENSITIVITY CORRECTION	DOMINANT PROJECT NOISE SOURCE		PROJECT YDNL	COMBINED YDNL	NORMALIZED YDNL	IMPACT SIGNIFICANCE		
				DESCRIPTION	EFFECTIVE DURATION				LAND USE HEALTH AND WELFARE	COMMUNITY REACTION	OVERALL
Bonaparte Indian Reserve 1		40 - 50	+10	North Valley Dump-Filling	Perm.	45 - 62	48 - 62	45 - 72	Insig. - Low	Insig.-High	Mod
Upper Hat Creek Valley	E. Lehman	35 - 40	+15	North Valley Dump Filling	Perm	46	46 - 47	61	Insig.	Mod.	Mod.
	M. Saulte & I. Lehman	35 - 40	+15	North Valley Dump-Filling	Perm	41	42 - 43.5	56	Insig.	Low	Low
	A. Parke & D. Ridlar	35 - 40	+15	Plant Construction	Perm	30 - 32	36 - 40.5	45 - 47	Insig.	Insig.	Insig.
Thompson-Bonaparte River Confluence		55 - 62	0	River Bottom Preparation	L.T.T.	46 - 56	55 - 63	46 -56	Insig.-Low	Insig.	Insig.
		55 - 62	+5	Water Intake Construction	L.T.T.	54 - 65	58 - 67	59 -70	Low	Low-High	Mod
		55 - 62	0	Pumping Station Construction	L.T.T.	57 - 69	60 - 70	57 -69	Low - Mod.	Low-High	Mod
North-Ashcroft Subdivision		50 - 56	+5	Water Pipeline Construction	S.T.T.	41 - 54	50 - 58	46 -59	Insig. - Low	Insig.-Low	Low
Semlin Valley Near Airstrip Site "C"		49 - 60	0	Airstrip Construction	Perm.	54	55 - 61	54	Insig.-Low	Insig.	Low

NOTE: Perm = Permanent; 10 years or more L.T.T. = Long-Term Temporary; 6 months to 10 years
S.T.T. = Short-term temporary; less than six months.

TABLE 6-10: IMPACT SIGNIFICANCE OF FIRST YEAR (CONSTRUCTION) PROJECT NOISE AT RESIDENTIAL LOCATIONS.
(ALL NOISE LEVELS IN dB re 20 μPa)

RESIDENTIAL LOCATION		EXISTING YDNL	COMMUNITY SENSITIVITY CORRECTION	DOMINANT PROJECT NOISE SOURCE		PROJECT YDNL	COMBINED YDNL	NORMALIZED YDNL	IMPACT SIGNIFICANCE		
				DESCRIPTION	EFFECTIVE DURATION				LAND USE/HEALTH AND WELFARE	COMMUNITY REACTION	OVERALL
Bonaparte Indian Reserve 1		45 - 55	+10 to +15*	Mine & Coal Preparation and Plant Operation	Perm.	44 - 62	48 - 62	59 -72	Insig. - Low	Low - High	Mod
UPPER HAT CREEK VALLEY	M. Saulte & I. Lehman	35 - 40	+15	Mine Operation	Perm.	63	63	78	Low	Extreme	Extreme
UPPER HAT CREEK VALLEY	A. Parke	35 - 40	+15	Mine Operation	Perm	49	49	64	Insig.	Mod.	Mod.
UPPER HAT CREEK VALLEY	D. Ridlar	35 - 40	+15	Mine Operation	Perm.	45	45 - 46	60	Insig.	Mod.	Mod.
UPPER HAT CREEK VALLEY	A. Pocock & G. Parke	35 - 40	+20*	Mine & Plant Operation	Perm.	35 - 36	38 - 41	55 -56	Insig.	Insig-Low	Insig.
Thompson-Bonaparte River Confluence		55 - 62	+10	Pumping Station 1 Operation (no fan noise control)	Perm.	56 - 66	59 - 67.5	66 - 76	Low - Mod.	Mod. - Extreme	High
North-Ascroft Subdivision		50 - 56	0 to +5	Offloading Facility Operation (Trucking)	Perm .	51 - 55	54 - 58	46 - 55	Low	Insig.	Low
Semlin Valley Near Airstrip Site C		50 - 62	0	Airstrip Operation	Perm.	40 - 50	53 - 62	40 - 50	Insig. - Low	Insig.	Low

Note: Perm. = Permanent; over 10 years
*At locations for which plant fan noise is clearly audible, the sensitivity is increased by 5 dB because of pure tone content.

TABLE 6-11: IMPACT SIGNIFICANCE OF FULL CAPACITY PROJECT OPERATION NOISE (MINING STAGE 6) AT RESIDENTIAL LOCATIONS (ALL NOISE LEVELS IN dB re 20 μPa)

The width of the strip of land around the mine pit made incompatible with grazing will not vary substantially throughout the mine's life. The incompatible area, however, will increase with the diameter of the pit. During Mining Stage 6, the strip will be about 600 m (2000 ft.) wide and excluding those adjacent areas to be taken up by other project components or to be within the range fencing [generally 50 to 100 m (160 to 330 ft.) from the pit rim], will contain an area of roughly 3.9 $km.^2$ (1.5 square miles). The pit itself at this stage will occupy roughly 5.1 $km.^2$ (2.0 square miles) so that the annulus around the pit which will be alienated largely by noise alone is quantitatively significance. Over 96% of the land in the vicinity of the Hat Creek Valley mine site is used to some extent for cattle grazing[105]. Therefore, about 3.7 $km.^2$ (1.4 square miles) of active grazing land will be rendered incompatible by mining noise.

Effective grazing is carried out only up to an elevation of about 1200 m (4000 ft.)[106]. The area in the Hat Creek Valley from Highway 12 to Blue Earth Creek is approximately 96 $km.^2$ (37.5 square miles) of which perhaps 86 $km.^2$ (34 square miles) supports some grazing. Therefore, the area alienated from grazing by mining noise during Stage 6 will be approximately 4.3% of the total grazing land available in the valley.

Present knowledge of the effects that environmental noise has on domestic and wild animals is very limited. Therefore, it cannot be said with any certainty how cattle will react to the mining noise. Since the overall noise from the mine will be quite continuous in level and nature (except for blasting, whistles, etc.), it is not likely that cattle will completely avoid the areas in which YDNL 65 is exceeded. But, presumably the presence of noise as a stressor will have some negative effects on the development of the cattle and will prevent the full utilization of the grazing land involved.

(ii) Agriculture

Croplands presently constitute less than 2% of the area of the mine site and environs[107]. The noise level criteria for agricultural lands [L_{eq}(24) 70 or approximately YDNL 76 for 24 hour/day noise] will not in general be exceeded beyond the rim of the pit, so that no noise impact on agricultural land is predicted for the Hat Creek Valley.

Similarly, none of the agricultural land reserve property in North Ashcroft will be exposed to incompatible noise levels from the make-up cooling water supply system activities except for the brief period of pipeline construction (less than 2 weeks).

(iii) Recreation

Only two known recreational areas will be exposed to significant levels of project noise; the most significant situation being at the McClean Lake Indian Reserve. Here noise from access road construction, and later traffic, will increase the environmental noise levels on the reserve substantially from the natural levels of YDNL 35 - 40. Road construction, while brief (about 50 workdays spent adjacent the reserve), will, when at its closest approach, create YDNL 66 at the southern edge of the reserve. Hence, a significant short-term impact could occur if this construction work coincided with a period of high recreational use of the reserve.

Access road traffic noise will be highest during the peak plant construction year of 1983, when it will cause perceptible increases in YDNL of from 3 to 10 dB over the southernmost 370 m (1200 ft.) of the reserve. While these increases in yearly average noise level are not overly significant, the intrusion of peak noise events (climbing trucks) will be clearly audible over much of the reserve and hence will detract from the enjoyment of the natural environment.

The second recreational area of concern is the Clear Range which forms the western rim of the Hat Creek Valley. This area is used by hikers and horseback riders. Even at the large distances involved [minimum of 6.4 km. (4 miles)] mining noise will be clearly audible on calm days in these elevated regions since it will have levels in the 35 to 40 dBA range. When combined with the visual impact of the pit and waste dumps, this noise will be distracted for people seeking to enjoy the tranquility of these mountains.

6.8 CONSERVATIVE ASSUMPTIONS IN THE NOISE IMPACT ANALYSIS

In order that the safety margins which have been incorporated in the noise impact analysis may be appreciated, the major conservative assumptions made are discussed below.

(a) Wind Attenuation

The sound-attenuating abilities of wind gradients and turbulence near the ground have been neglected because of the uncertainty of the existence of and the amount of attenuation over the hilly, uneven terrain of the Hat Creek site and environs.

Over flat terrain, this attenuation will reach its maximum value after sound has propagated 900 to 1200 m. (3000 to 4000 ft.), even in light winds. Many noise source-to-receptor distances from the mine and plant are of this order or larger.

Since wind attenuation is frequency dependent, being largest at high frequencies, the amount of noise reduction (in dBA) obtained depends on the spectrum of the noise in question. For example, the maximum flat-terrain, yearly-averaged wind attenuation that could be obtained for plant and mine operation noises (both have large low frequency content) is about 10 dBA. In comparison, steam-venting noise (which has most of its energy at high frequencies) could be wind-attenuated by from 18 to 20 dBA over a large distance.

When a source to receiver sound path lies, all or in part, well above the ground, as when crossing a valley or when either source or receiver is elevated, the amount of wind attenuation will be reduced due to the weaker wind gradients and turbulence encountered along this path. This will be the case with plant noise propagated into the valleys below, especially from elevated sources like the stack and the electromatic valves.

In propagating over uneven terrain, sound waves will encounter constantly fluctuating wind gradients. This too will have the effect of interfering with the steady, upward sound diffraction that results in wind attenuation.

It is, therefore, concluded that, in general, wind attenuation around the site and environs will be significantly less than the flat terrain values of from 10 to 20 dBA. Exactly how much less cannot be determined.

(b) Equipment Usage Factors

Because of the somewhat unique nature of much of the construction work in the Hat Creek Project, and the lack of detailed construction schedules at the time of the environmental studies, it has been necessary to make conservative estimates of the degrees to which many types of construction equipment will be used. In general, when no other information was available, the usage factors of such equipment were set at between 0.5 and 0.75 for the entire duration of the construction project. However, it is quite possible that some of this equipment may see only occasional use throughout the project while other types may be used intensively during a particular construction phase and then retired.

Each doubling of a machine's usage factor causes its time-averaged noise level to increase by 3 dB. Therefore, if it is conceded that the above conservative approach can overestimate the usage factor of a particular piece of equipment by two to four times, then its effective noise level can be overestimated by 3 to 6 dB.

If the particular piece of equipment happens to be one of the noisiest on the job, this overestimate can be transferred, all or in part, to the total noise level predicted for the construction project.

A shift in YDNL of 3 to 6 dB can be of significance to the noise receptors. Referring to Figure 5-1 it is seen that a 5 dB increase in normalized YDNL, within the 50 to 70 dB range, generally shifts the community reaction up to the next level of severity.

It is concluded that the conservative estimation of construction equipment usage factors can potentially cause a significant increase in the predicted impact of construction noise on neighbouring communities.

7.0 MITIGATION AND COMPENSATION

7.1 MITIGATION OF PROJECT NOISE IMPACTS

Mitigation of project noise should be considered when the following conditions exist :

1. when the noise impact is judged to be significant (i.e. impact significance category is low, moderate, high or extreme),

2. when the cost of mitigation is roughly comparable to or less than the perceived benefit of the resulting noise reduction.

Noise mitigation measures are proposed below for the construction and operation of the mine, plant and offsites.

In order for the project noise impacts predicted in this report to remain valid, all equipment must produce noise levels equal to or less than those given in Appendix B or elsewhere in the report. Those pieces of equipment which will not contribute significantly to the noise impact of the project have not been discussed in this section. However, the ultimate noise levels of these items should not be allowed to exceed the levels given in Appendix B without due consideration being given to the effects of such a change on the overall noise impact.

(a) Mitigation of Construction Noise

(i) Mobile Construction Equipment

Exterior noise level data should be obtained for all mobile equipment to be used in the construction of the mine, plant and offsites. The noise levels, in octave bands, for a generic equipment type should not exceed those given in Appendix B when measured under normal operating load conditions at a distance of 15 m (50 ft.).

Once suitably quiet equipment has been selected, its noise levels should be prevented from increasing with time through a regular maintenance program. At the large distances [greater than 900 m (3000 ft)] that generally will exist between construction sites and human noise receptors other than construction workers, the low-frequency diesel exhaust noise will be the major concern. Therefore, all mobile equipment should be maintained with a stock or better exhaust muffler in good working condition. The deterioration of mufflers, as well as other equipment disrepair, could be identified through regular noise level measurements at a set distance under set load conditions.

At those construction sites, such as for the make-up water intake and booster pumping station at Ashcroft, which involve fewer pieces of equipment and shorter distance from the noise source to human receptors, the noise from idling equipment could become significant. Therefore, a policy should be considered of shutting down all equipment when not in active use.

It has been assumed, except in the case of the North Valley Dump-filling operation, that construction will be done only during a single 8-hour day shift. Any significant extension of these work hours will invalidate the impact assessment. Nighttime or weekend construction should generally be avoided. The Village of Ashcroft Noise By-Law No. 280, prohibits any disturbing construction activities between the hours of 9.00 P.M. and 7.00 A.M. without the written consent of the Village Clerk. This by-law would apply to the construction of the make-up water intake and booster pumping station 1.

(ii) Construction Blasting Noise and Vibration

Criteria for peak noise levels and ground vibration levels from blasting operations were given in Sections 5.2 f and h respectively. As the details of construction blasting programs are not yet known, the levels of noise and vibration to be generated have not been estimated.

To aid in the attainment of the above-mentioned noise criterion, electronic detonation should be used whenever possible. Noise and vibration levels can be controlled through the type and size of surface and ground charges used. Where blasting is to be done near residential areas such as at Ashcroft, the blasts should be designed to meet the above criteria at the nearest occupied dwelling and if a series of blasts are planned, the noise and vibration levels should be monitored to assure compliance.

(iii) Mine Construction Transformers

During mine construction, the nighttime project noise levels near the mine mouth will be controlled by the two construction transformer which will operate continuously. The pure-tone transformer noise will be audible over the southwest end of Bonaparte Reserve 1. Therefore, a noise barrier should be provided on the north side of the transformers, either in the form of a building or a special wall. The barrier should provide approximately 10 dB attenuation at the frequency of the pure tone.

(iv) Plant Steam Line Blowouts

Steam line blowouts, prior to start-up of each generating unit, will produce dangerously high noise levels for unprotected workers near the plant [140 dBA at 30 m (100 ft.)] and may cause severe startle to wild animals and cattle to the east of the plant [100 dBA at 900 m (3000 ft.)]. Therefore, the steam line outlets should be fitted, during each blowout, with a silencer giving an attenuation of 25 dBA or more.

(b) Mitigation of Operation Noise

(i) Mine Operation

A. Mobile Mining Equipment

As with mobile construction equipment, mobile mining equipment should be selected which has rated exterior noise levels at 15 m (50 ft.) which are equal to or less than those given in Appendix B. These rated noise levels should be maintained through routine maintenance, especially of exhaust mufflers. A routine noise measurement program should be established to aid in identifying muffler deterioration and other equipment disrepair. Muffler maintenance is particularly important for scrapers, trucks and other mobile equipment which regularly operate outside the pit. This also applies to the mobile clean-up equipment to be used around the coal stockpiles.

B. Coal Stacking and Reclaiming

The conveyors and bucket wheels of the coal stacking and reclaiming system are not inherently noisy, although their noise increases significantly with speed. However, if not properly maintained, they can generate high level and very annoying squeals and whirring sounds. Again, noise and/or vibration measurements can prove to be valuable preventive maintenance tools.

C. Pit Blasting

Since pit blasting will be restricted to the daytime, it will not have significant impact on Bonaparte Reserve 1 or Hat Creek Valley residents. In the interest of reducing peak noise levels in the pit, the grains/ft. of the primer cord can be reduced when feasible and the cord can be covered with sand. Under the blasting conditions described in Section 4.3 b (iii) A, the Worker's Compensation Board Limit for impulsive noise of 140 dB peak Linear would be exceeded within approximately 450 m (1500 ft.) of the blast centre. Workers within this area would be required to wear hearing protection.

D. Mine Public Address System

The mine public address and signal systems, particularly those portions near the coal preparation area, are a potential source of annoyance. The noise levels have not been predicted but they should not exceed the criterion established in 5.2 e.

In order to comply with this criterion, the design of these systems should incorporate the following:

1. distributed speaker and warning device systems rather than a smaller number of very powerful centralized units.
2. coverage of speakers should be confined to the areas where it is needed though selection of highly direction speakers or the use of baffles.
3. Use radio communication as much as possible; either one-way FM or two-way VHF.

(ii) Plant Operation

A. Induced Draft Fans

Plant operation noise levels at the north end of Bonaparte Reserve 1 will be dominated by induced-draft fan noise from the stack, assuming worst case fan selection. If any other of the four fan manufacturers is selected (see Appendix B), the plant noise at Reserve 1 would drop about 5 dB to YDNL 35-40, where this level would be maintained by plant wall radiation. Therefore, from the environmental noise viewpoint, judicious fan selection is required but not necesarily silencing. The selection of quieter induced-draft fans would also render the pure-tone component of their noise largely undetectable above the other plant noise so that the subjective annoyance of the plant noise would be reduced more than is apparent from the 5 dB drop in YDNL.

B. Forced-Draft and Primary-Air Fans

Because of the location of their intakes at ground level on the east side of the boiler house, the forced-draft and primary air fans will not contribute significantly to the plant noise in the Hat Creek Valley. They could, however, create very high noise levels in the plant yard and cause a substantial area [4.0 $km.^2$ (1.6 sq. miles)]. to the east of the plant to be judged incompatible with cattle grazing (see Figure 6-12a)Depending on the make of fans selected, the Worker's Compensation Board of B.C. limit for an 8 hour per day exposure to steady noise of 90 dBA will be exceeded up to approximately 38 m (125 ft.) from the intake louvers to each fan room. Workers entering this area would have to wear hearing protection or alternatively access to the area would have to be restricted.

Therefore, it is recommended that one of the quieter fans makes (e.g. Novenko or Sheldons*, see Appendix B) be selected or that the intake louvres be fitted with silencers giving an attenuation of 10 to 15 dBA.

• Note that any proprietary products referred to herein are done so for illustrative purposes only and not for endorsement to the exclusion of other suitable products.

C. Boiler House and Turbine Hall Walls

When, as discussed in Section 4.3 a (i) A, a reverberant noise level of 95 dBA is assumed throughout the boiler house and turbine hall, and the transmission loss of the "base" wall section is applied, the plant wall-radiated noise is such that the reduction in overall plant noise at Bonaparte Reserve 1 to be gained by selecting quieter induced-draft fans (or silencing them) is limited to 5 to 6 dBA. Any change in the transmission loss of the walls at low frequencies (31.5 to 125 Hz.) will directly affect the plant noise levels at Reserve 1, if induced-draft fan noise has been significantly reduced through fan selection or silencing.

Two proposed alternate wall sections (Robertson Building Systems "Forma-Wall" and "Newline Panel"), have been reported to perform slightly better (2 dB) than the base wall section at 125 Hz. Based on mass law (6 dB reduction in transmission loss with each halving of frequency) extrapolation, this 2 dB advantage will be maintained at 63 and 31.5 Hz. Therefore, from the standpoint of environmental noise levels at distant receptor locations, the two alternate wall sections would perform as well or slightly better than the base wall section (see Appendix B, Table B-8)*.

Although the Forma-Walls' transmission loss at 1000 Hz. is 11 dB poorer than that of the base wall section, the overall noise attenuation of the panel, in DBA, will not be affected since the low frequency noise components will be dominant.

Another way to reduce plant wall-radiated noise is to reduce the reverberant noise levels inside the boiler house and turbine hall. This can be done through noise control of specific machines (i.e. noise source control) or through the addition of sound absorptive materials to the interior surfaces of the buildings. The exterior wall or roof sections themselves can provide absorption if their insulating material is porous (e.g. fibreglass or mineral wool) and their interior steel facing suitably perforated. The sound transmission loss of such wall sections are comparable to those of sections without perforations[109]. An obvious side-benefit to such treatments is a reduction in plant worker noise exposure.

D. Transformers

The 500 kV transformers are the third most significant source of continuous plant noise in the Hat Creek Valley. Reducing their noise levels below those given in Table 8-6 of Appendix 8 would not have much effect at distant receptor locations unless both the *induced draft fan and the boiler house and turbine hall wall noise* levels were reduced significantly. However, because of the pure tone content of transformer noise and because any increase in transformer noise of more than 1 or 2 dB at low frequencies will cause an incremental increase in overall plant noise level, the transformer noise levels reaching the environment** should not be allowed to exceed those of Table 8-6.

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* Note that any proprietary products referred to herein are done so for illustrative purposes only and not for endorsement to the exclusion of other suitable products.

** Distinction is made here between the noise levels of the untreated transformers and those of transformers which are enclosed or otherwise quietened.

E. Electromatic Valves

Electromatic valves will produce very high noise levels [128 dBA at 30 m (100 ft.)] without warning. Therefore, they present risks of hearing damage to plant workers and of severe startle to plant workers and neighbouring animals.

The edges of the boiler house roof will provide a certain amount of shielding for people on the ground near the plant. However, it is conceivable that plant construction workers could be on the roof when the valves of an already operating unit open. Plant workers should therefore be protected from such risks by silencing these valves (25 dBA or more) and/or through the mandatory wearing of hearing protection. Only silencing would alleviate animal startle.

F. Circuit Breakers

Impulsive noise levels from the 500 KV air-blast circuit breakers cannot be predicted accurately as data was not available from the most probable supplier. However, data on similar units show that, in the extreme, these peak levels could reach 160 dB Linear at 15 m (50 ft.). Therefore, the Worker's Compensation Board of B.C. limit for a single event exposure of 140 dB could be exceeded at up to 150 m (500 ft.).

The circuit breakers which are selected should not exceed 140 dB peak Linear at the closest permissible approach distance of unprotected workers. Since two breakers usually trip simultaneously this corresponds to 137 dB from a single unit. These levels can be achieved either by restricting access to a suitably large area around the switchyard, or by selecting inherently quieter breakers (e.g. inert-gas type) or fitting the noisier type (air-blast) with discharge silencers.

G. Plant Public Address System

The Public Address and signal systems at the plant will not present a problem in the Hat Creek Valley, however, in the interest of minimizing the environmental degradation of the Trachyte Hills, these systems should be designed to control the spread of sound beyond the areas intended to be served. This can be done by selecting a distributed (localized) speaker system with highly directional speaker arrays and by using personalized radio communications were possible.

(iii) Offsites Operation

A. Make-up Cooling Water Supply Booster Pumping Stations

With worst case, unsilenced ventilation fans in the end walls of booster pumping station 1, the operating noise impact significance at the Bonaparte-Thompson residential area will be classed as "High" (see Table 6-11). Therefore quieter fan selection and/or fan intake silencing should be done to the extent of providing a 25 dBA reduction. The impact significance would then be reduced to "Insignificant" and the station transformer noise would become the dominant noise source. This transformer noise would still be quite noticeable outdoors in the residential area to the north so that effective shielding in the form of a stub wall or screen on the north side of the transformer should be provided. Roof top exhaust fans should also be selected with quiet operation in mind.

At pumping station 2, ventilation fan noise should also be controlled through selection and/or silencing in order to minimize environmental degradation. Transformer noise will not require attention.

B. Access Road

To limit access road traffic noise impact (on the McClean Lake Indian Reserve primarily; See Figure 6-16) during peak construction years, it should be assured that heavy supply trucks are fitted with stock or better exhaust silencers and that these are maintained. Restriction of heavy trucking to weekdays would likely be beneficial.

C. Airstrip

At Airstrip Site A, operating noise will have no significant impact. At Site C, the noise impact significance will be "Low" (Table 6-11) assuming only daytime flying. However, at Site C, the overall impact, as reflected in annoyance, of light aircraft operations may be more severe than indicated by noise impact considerations alone. Feelings of trepidation could result because of the very low altitudes at which the aircraft would fly over the buildings (possibly residences among them) located approximately 300 m (1000 ft.) west of Site C. The noise levels and the overall impact of the aircraft operations could be reduced somewhat if the aircrafts were to operate at their maximum glide slopes. A much more substantial improvement could be made by relocating the airstrip so that its approach paths do not pass over residences, at least not until the aircraft will have attained an altitude of 90 m (300 ft.) or more.

D. Equipment Offloading Facilities

If the Spences Bridge site is selected, the impact of equipment trucking would be minimal because of the existing high noise levels from Highway 1 and CPR and CNR mainlines. At the other two sites, particularly the J & B Lumber site at Ashcroft, this trucking noise would create noise impacts. At the Ashcroft site, this impact would be "Low" as indicated in Table 6-11. The impact at Kelly Lake has not been predicted, but it would likely be of a level similar to that at Ashcroft. The number of people exposed to the noise, however, would likely be considerably less at Kelly Lake.

To minimize the impact of both the trucking and the equipment offloading operation itself, all trucks, forklifts and cranes should be equipped and maintained with stock or better exhaust mufflers. To maintain the validity of the predicted noise impact, highway truck noise levels should at no time exceed those given for highway trucks in Appendix B, i.e. 85 dBA at 15 m (50 ft.) Equipment should be shut down when not in active use.

The trucking route through neighbouring communities should be selected in conference with local officials to avoid, as much as possible, residential areas, schools and hospitals, particularly if the adjacent road has an upgrade in the direction which the loaded trucks will be travelling.

7.2 COMPENSATION FOR PROJECT NOISE IMPACTS

In situations where project noise impact cannot be reduced to insignificant levels through mitigative actions, compensation should be considered. The areas in which this situation could exist are the Bonaparte Indian Reserve No. 1 and the Hat Creek Valley ranching region. It is not considered that compensation would be payable to persons exposed only temporarily to significant noise levels such as near the Thompson River intake for the make-up cooling water system.

Two basic categories of noise impact have been discussed throughout this report. They are :

1. Where project noise levels are incompatible with the best use (generally taken as the present use) of the land. The limits for compatible land use were established in Section 5.0 as YDNL 55 and 65 for residential and cattle grazing lands respectively, and L_{eq}(24) 70 for agricultural lands.

2. Where the project causes an increase in environmental noise levels but the increased levels are still compatible with the best land use.

In the first case the owner of the impacted land has either to sell or trade his land to B.C. Hydro or to stay on the land and operate it at less than its best land use.

If B.C. Hydro purchases the property then the difference between the purchase price and the fair market-value (if a positive figure) could be considered to be compensation for having to move or, in the case of the owner leasing back the property, for the loss of ownership and subsequent exposure to to project impacts, noise as well as any others. There is a precedent, in the creation of buffer zones around major airports, for the purchase of property solely on the basis of noise impact. Properties at which the project operation noise levels are expected to be incompatible with best land use and at which noise could be one of the worst, if not the worst, project impact include the Hat Creek Valley properties of Ed Lehman, M. Sualte and Ike Lehman, and the southwest corner of the Bonaparte Reserve 1 (see Figure 6-12). A cash settlement approach to compensation might be more applicable to the Hat Creek Valley ranch properties while impacted Indian Lands might be more amenable to replacement in kind (i.e. a land exchange).

If the owner does not sell and remains on the land, he could be considered eligible for compensation for his exposure to project noise and other impacts, but no firm basis or precedent exists by which the amount of compensation could be established. Some possible indicators could be the difference in land values with and without the project, or the decrease in the present value of future revenues caused by operating the land at other than its best use.

In the second case, where noise levels increase but remain compatible with best land use, there is no precedent for the purchase of impacted lands solely on the basis of the degradation of the acoustic environment. However, this does not mean that no compensation is warranted, since, as discussed in Section 5.0, a noise intruding into a residential area can have significant impact through the creation of annoyance without its exceeding levels considered detremental to public health and welfare. Alternately, B.C. Hydro may feel that purchasing is justified in light of the total impact of the project on the properties concerned. Properties which will likely fall into this second category are the Hat Creek Valley ranches of A. Parke, D. Ridlar (Baldwin), A. Pocock and G. Parke, and the majority of Bonaparte Reserve 1 (shown non-hachured in Figure 6 - 12). With practical degrees of booster pumping station noise control, the project operating noise impact on the residential area at the Thompson-Bonaparte River confluence will be at the insignificant level and hence compensation will not likely have to be considered.

It should be noted that compensation of any kind specifically for noise impact should be based on the noise levels that are shown by field measurements to exist during project construction and operation and not on the noise levels predicted in this report. The predicted noise levels are conservative and will therefore be somewhat higher than the measured levels.

Appendix D presents guidelines for the assignment of project costs to noise impacts of the two basic types discussed above. These guidelines were drawn jointly by Harford, Kennedy, Wakefield Ltd. and Strong Hall & Associates.

7.3 EFFECTS OF PROJECT NOISE MITIGATION ON IMPACT SIGNIFICANCE

Some of the project noise mitigation measures recommended in Section 7.1 would result in a downward shift in overall impact significance category, while others would simply reduce the degree of environmental degradation caused by the project. Those mitigative measures for which quantitative noise reductions can be identified, are listed in Table 7-1 along with the "with and without - mitigation" impact significance categories where these can be established.

NOISE SOURCE	MITIGATIVE ACTION	SOURCE NOISE REDUCTION* (dB)	RECEPTOR LOCATION	OVERALL IMPACT SIGNIFICANCE		COMMENTS
				WITHOUT MITIGATION	WITH MITIGATION	
Induced-Draft Fans (Plant)	Fan Selection and/or Silencing	15+	Bonaparte Indian Reserve 1 (North end only)	Low	Insig.	Benefits only areas where plant noise dominates. Reduction of pure tone makes noise less annoying.
Forced-Draft and Primary-Air Fans (Plant)	Fan Selection and/or Silencing	12+	Trachyte Hills east of plant (Grazing)	Low	Insig.	Area where YDNL exceeds 65 is reduced to essentially within the plant boundaries.
Steam Line Blowouts (Plant)	Silencers and/or Hearing Protection for Workers	25(A)	Plant yard and Grazing land to east of plant	--	--	Plant workers protected against hearing damage and cattle and wildlife startle effects largely reduced. (With silencing only)
Electromatic Valves (Plant)	Silencers	25(A)	Plant yard and Grazing land to east of plant.	--	--	Plant workers protected against hearing damage and startle reduced. Cattle and wildlife startle reduced.
Mine Construction Transformers	Barrier on North side	10+	Bonaparte Reserve 1 (Southern boundary)	Insig. - Low	Insig.	Without barrier, pure tone noise would be audible at night. With barrier, it would be inaudible.
Booster Pumping Station 1 Fans and Transformer	Ventilation fan selection and/or silencing. Transformer barrier	Fans: 25(A) Transformer 10(A)	Residential Area at Confluence of Bonaparte and Thompson Rivers	High	Insig.	Fan and transformer noise would still be audible during quiet periods (e.g. between train events, low winds) but impact will be insignificant.

*Noise reductions refer either to the A-weighted sound level (A), or to the level in the controlling octave band at the receptor location.

TABLE 7-1: EFFECTS OF NOISE SOURCE MITIGATIVE ACTIONS ON NOISE IMPACT SIGNIFICANCE

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GLOSSARY

A-Weighting:

An electronic weighting circuit incorporated into most instrumentation used for community noise monitoring. The sound level meter with A-weighting is progressively less sensitive to sounds of frequency below 1000 hertz and above 4000 hertz to simulate the frequency response characterictics of the human ear.

Continuous Noise

On-going whose intensity remains at a measurable level (which may vary) without interruption over an indefinite period or a specified period of time.

Day-night average sound level (L_{dn})

The 24-hour average sound level, in A-weighted decibels, obtained after addition of 10 decibels to sound levels in the night from 10:00 p.m. to 7:00 a.m. The average sound level is defined as the A-weighted sound level which, over a given period of time, contains the same total sound energy as the actual time-varying level over the same period of time.

dBA (A-weighted Decibel)

The unit of sound pressure level most commonly used when dealing with the effects of noise on humans. This level is obtained by summing the sound level contributions from all audible frequencies after applying a weighting network that approximates the frequency response (sensitivity) of the human ear.

Decibel (dB)

Is the unit of sound pressure level, sound power level and other levels, where a level is defined as ten times the common logarithm of the ratio of the quantity in question (sound pressure, power etc.) to an appropriate reference quantity.

Equivalent Sound Level (L_{eq})

The level of a constant A-weighted sound which, in a given situation and time period, has the same sound energy as does a time-varying sound. More precisely it is the time-weighted, mean-square, A-weighted sound pressure level. $L_{eq}(24)$ is L_{eq} computed over an entire day.

Fast response

A standardized response time provided on sound level meters. It represents a squared pressure time constant of 125 ms.

Intermittent Noise

Fluctuating noise whose level falls once or more times to low or unmeasurable values during an exposure. In this document, intermittent noise will mean noise that is below 65 dBA at least 10% of any one hour period.

Noise

Acoustic noise is commonly defined as sound which, in the opinion of a given receiver at a given time and place, is unwanted or annoying.

Peak Sound level

The greatest instantaneous sound level during a designated time interval or event.

Slow response

A standardized response time provided on sound level meters. It represents a squared-pressure time constant of one second.

Sound Power Level (SWL) $= 10 \text{ Log.} \frac{W}{W_o}$ (dB)

Where: W = sound power of the source in watts

W_o = reference sound power

$= 10^{-12}$ watts.

Sound Pressure Level (SPL) $= 10 \text{ Log.} \frac{P^2}{P_{ref}^2}$ (dB)

Where: P = root mean square (rms) acoustic or sound pressure expressed in Newtons per square meter (N/m^2)

P_{ref} = reference rms sound pressure

$= 2 \times 10^{-5}$ N/m^2

Statistical Indices

The statistical indices, (L_i) represent the sound levels exceeded i% of a stated time interval. For example L_{10} represents the level exceeded 10% of the time.

Yearly day-night average noise level (YDNL):

Is the logarithmic average of the day-night average sound level (L_{dn}) over a full year.

APPENDICES

APPENDIX A

BASELINE NOISE MONITORING
HAT CREEK STUDY

Harford, Kennedy, Wakefield Ltd.

TABLE OF CONTENTS

1.0 INTRODUCTION

Ambient noise levels were monitored throughout the Hat Creek Valley in October, 1976 and again in February and March, 1977. Measurements were conducted during two different seasons of the year to determine whether significant differences in ambient noise level would result due to the presence of snow on the ground or to different levels of activity in the area. The purpose of the monitoring was to provide part of the information necessary to evaluate future noise impact. Furthermore, the data obtained will provide a reference in the future should community noise problems ever develop. This report documents the procedures and instrumentation employed and presents the results obtained.

2.0 DATA ACQUISITION

2.1 Equipment

a) Fall Measurements

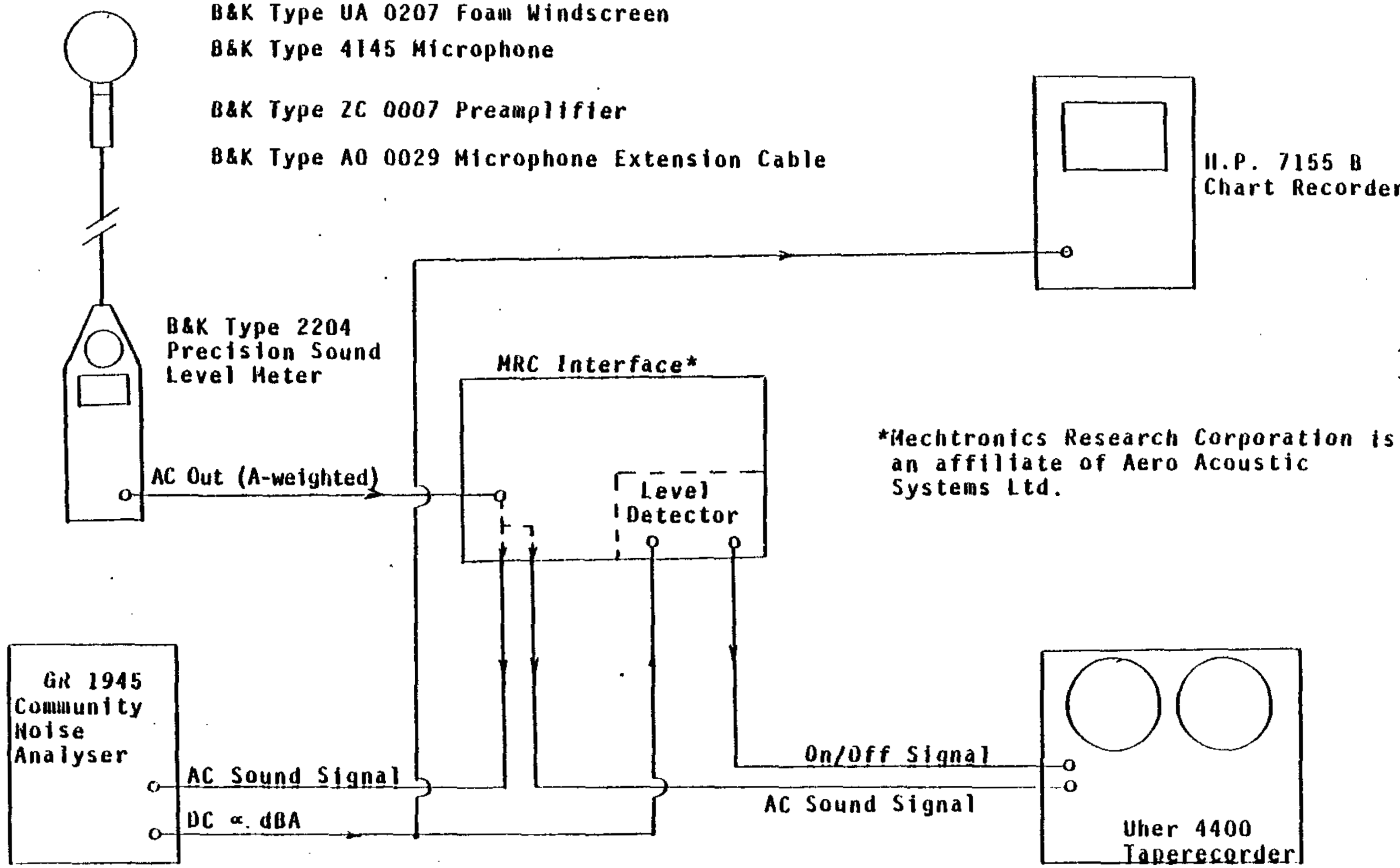
The sound monitoring equipment used for the fall measurements is illustrated in Figure 2.1a. The instruments used for the periodic octave band analyses of the background noise levels were the following:

a) Bruel & Kjaer Type 2204 Precision Sound Level Meter
b) Bruel & Kjaer Type 1613 Octave Band Filter Set

Calibration of the monitoring system was checked periodically using the Bruel & Kjaer Type 4230, 94 dB calibrator.

Informal weather measurements were taken from time to time using the following equipment:

Dwyer Mark II Wind Speed Indicator
Weksler Wet and Dry Bulb Thermometer



(2)

Figure 2.1a: Fall Monitoring System Schematic

2.1 Equipment (cont'd)

b) Winter Measurements

For the winter monitoring the measurement system was modified slightly. A Bruel & Kjaer Type 4165 quartz coated microphone with dehumidifier was used with the same sound level meter and analyser used in the Fall Measurements. The entire monitoring system is illustrated in Figure 2.1b.

The wind speed indicator used in these measurements was a Tradewinds Type 108 JH whirling cup anemometer, with the output connected via a tone generator to the taperecorder for a record of the wind speed with each intruding noise event (see Section 2.2(b)).

2.2 Procedures

a) Fall Measurements

A continuous chart recording approximating a "fast" response was obtained from the HP Chart Recorder. During the manned portions of the monitoring period, intruding events were noted directly onto the chart. When the lab was unmanned, the intruding events on the chart recording were later identified by listening to the taperecorded events. The taperecorder had been set up to turn on whenever the sound level exceeded a preset value. This value varied from site to site depending on the level of activity. Once the taperecorder had been triggered, it remained on for at least 5 seconds.

The entire system was calibrated periodically using the B & K Type 4230 Calibrator. No adjustments were found to be necessary to keep the calibration within ± 0.5 dBA.

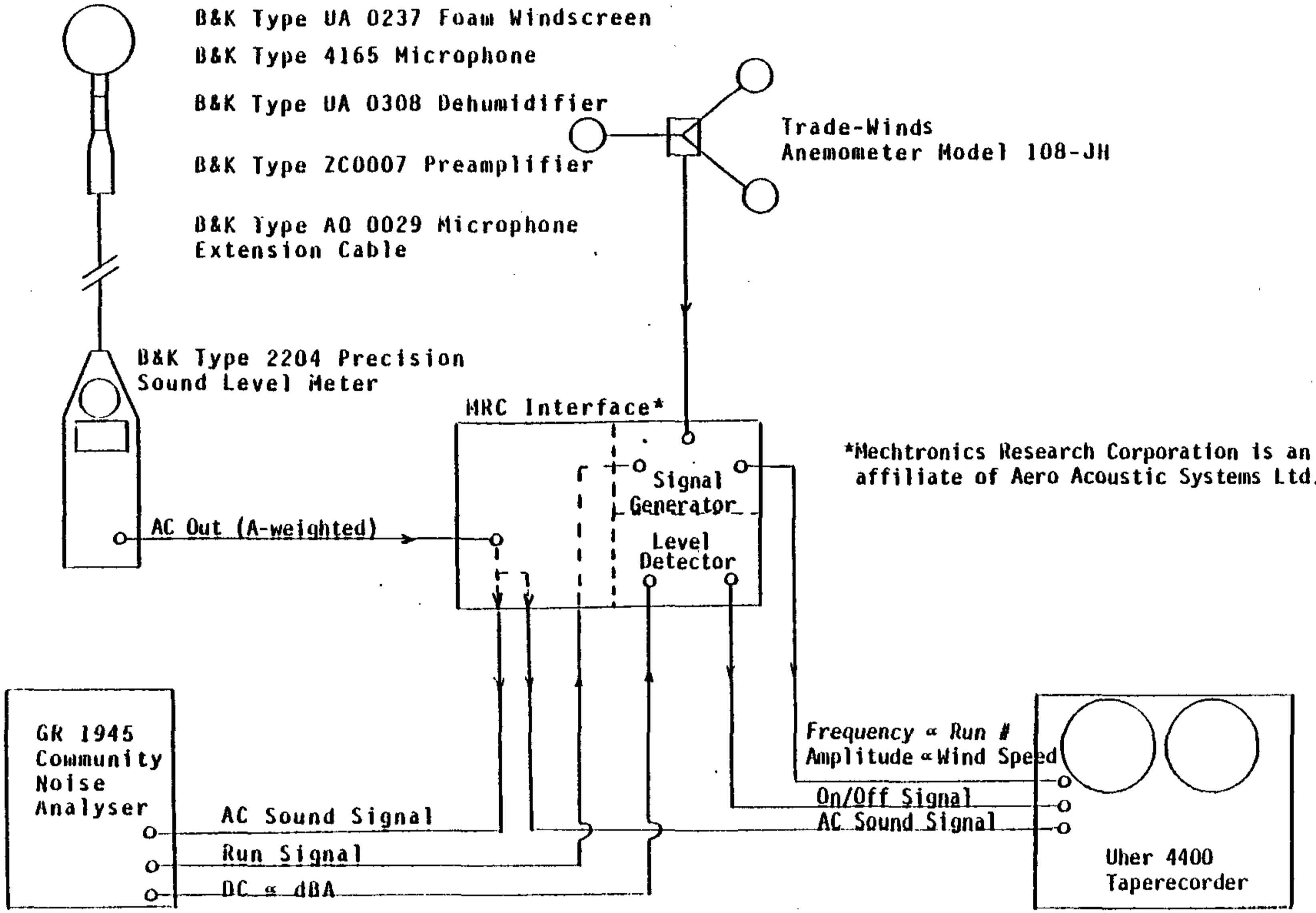


Figure 2.1b: Winter Monitoring System Schematic

2.2 Procedures (cont'd)

a) Fall Measurements (cont'd)

Periodically, samples of the background noise level were taken by the field engineer. These readings were obtained by using the "slow" meter response and waiting for those moments when there were no identifiable intruding events such as motor vehicles close by.

From time to time, when changes were apparent, meteorological measurements were also taken and recorded by hand.

b) Winter Measurements

All of the winter measurements were taken with the lab unmanned. That is, the taperecordings were used to identify the intruding events. Chart recordings were not made in the field, but generated in the lab by playing back the taperecordings. A signal from the General Radio 1945 Community Noise Analyser to the taperecorder indicated which analyser memory was active when an event was recorded. Three different frequencies were used to indicate the active memory. Hence it was possible to determine the portion of the day during which any recorded event occured. In addition, the amplitude of the tone was varied in proportion to the wind speed to provide a direct recording of the wind speed with each intruding event (see Figure 2.1b).

Occassional measurements were made of background noise levels (in octave bands) at each monitoring site. Meteorological data supplementary to the wind speed which was recorded at the microphone position, was obtained from nearby B.C. Hydro weather monitoring stations since all of the winter noise monitoring was done on an unmanned basis.

2.3 Site Descriptions

Four sites were chosen in an attempt to obtain readings indicative of the existing noise environment in the valley. Site 1 was chosen to be indicative of properties near Highway 12, west of the Hat Creek junction. Site 2 was essentially at the Hat Creek junction, and will be considered as indicative of properties near to Highway 12 east of the junction. Site 3 was chosen to be indicative of the properties near the Hat Creek Road, but away from the influence of Highway 12. Site 4 was selected as a sample of the noise environment which could be expected at sites well removed from any of the frequently travelled roads, indicative of the essentially pristine areas of the valley. The general location of all four sites is indicated in Figure 2.3.

2.3-1 Site 1

Site 1 was located approximately one mile north of the junction of the Hat Creek road with Highway 12. The site was situated on an old gravel road which paralleled Highway 12. Photographs of the site are shown in Figure 2.3-1a. The areas on either side of the highway were wooded. The microphone was located approximately 150 feet from Highway 12 as shown in Figure 2.3-1b. During the winter monitoring, there were several inches of crusty snow on the ground in the immediate area.

The main noise sources were traffic on the highway, the Steel Bros. Cement Plant (approximately 1 mile to the north on Highway 12), squirrels and birds, and wind in roughly that order of significance.

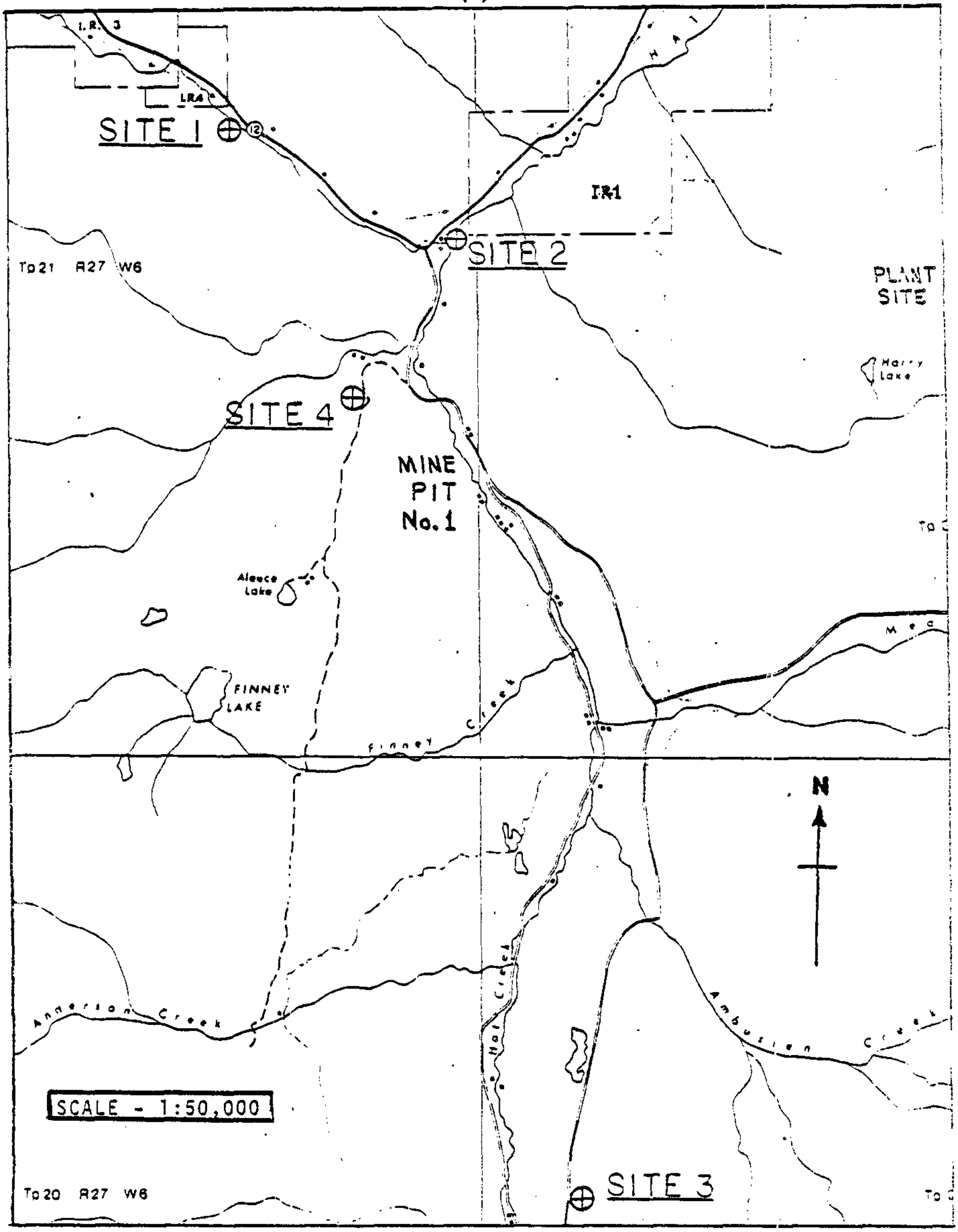


FIGURE 2-3: BASELINE NOISE MONITORING SITES IN THE HAT CREEK VALLEY

HARFORD, KENNEDY, WAKEFIELD LTD.

View Looking S.W. Across Highway 12 at noise Monitoring Lab.

View looking N.W. along Highway 12 showing noise monitoring lab parked below and to left of highway.

View looking S.E. along Highway 12 showing noise monitoring lab parked below and to right of highway.

Figure 2.3-1a: Site 1 Photographs

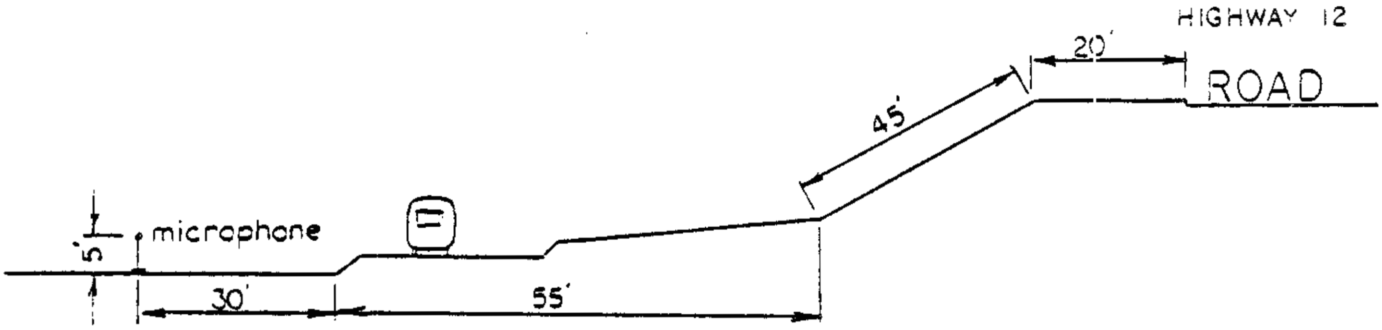


Figure 2.3-1b: Site 1 (not to scale)
Cross section as seen looking N.W.
(Similar view to centre photograph
on preceding page).

2.3-1 Site 1 (cont'd)

The traffic in the fall consisted of a varied mixture of small vehicles (cars, pickups, vans and campers) and trucks, Some of the trucks were operating back and forth on a regular basis. These included lumber trucks which represented a large percentage of the truck traffic on weekdays and hopper trucks (CP and Trimac). Some B.C. Hydro and B.C. Tel vehicles were also noted. Winter traffic was only identified as either cars or trucks since identification was made from tape recordings.

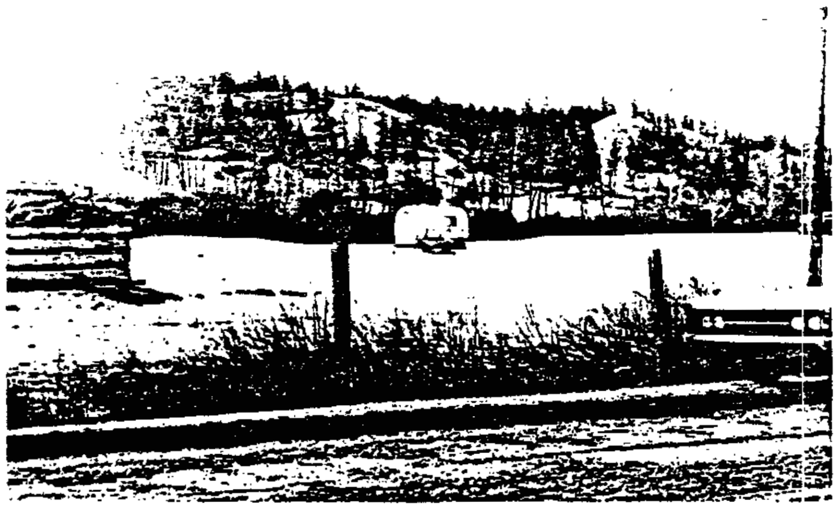
Noise from the cement plant appeared to originate from conveyors and crushers however some of the louder events associated with the plant were produced by rock drills and caterpillar activity on the rock face above the plant. One dynamite blast was recorded originating from the vicinity of the plant.

2.3-2 Site 2

Site 2 was located in a small field on the south side of Highway 12 approximately 300 feet east of the Hat Creek junction. Photographs of this site are shown in Figure 2.3-2. The microphone was located approximately 150 feet from Highway 12. There were a few inches of crusty snow at the site on February 14, 1977 but on March 6, 1977 there was no snow remaining.

The main noise events were traffic on Highway 12 with the same type of mix as Site 1. Some events were recorded for traffic travelling on the Hat Creek road but the number of these was small compared to the traffic on Highway 12.

View looking S.E. across Highway 12 at noise monitoring lab.



View looking N.E. across Hat Creek Rd. at noise monitoring lab. Highway 12 intersects at left.

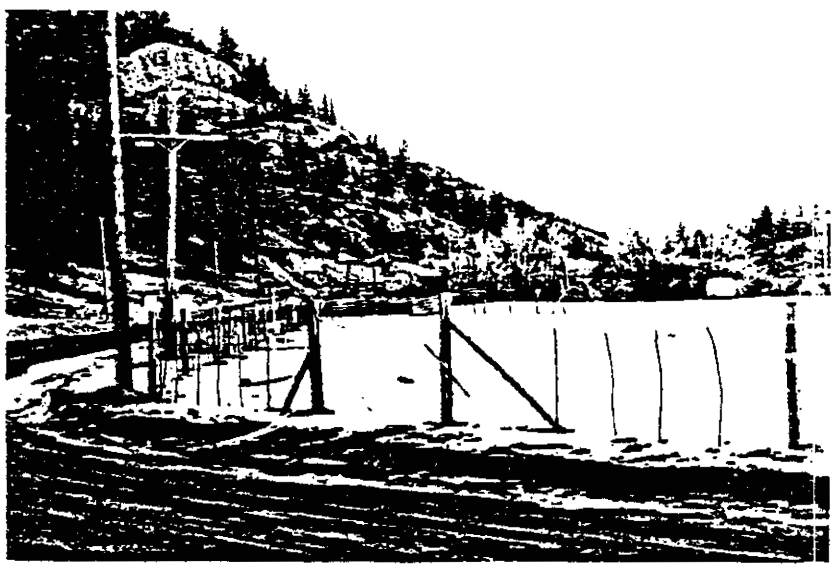


Figure 2.3-2: Site 2 Photographs

2.3-2 Site 2 (cont'd)

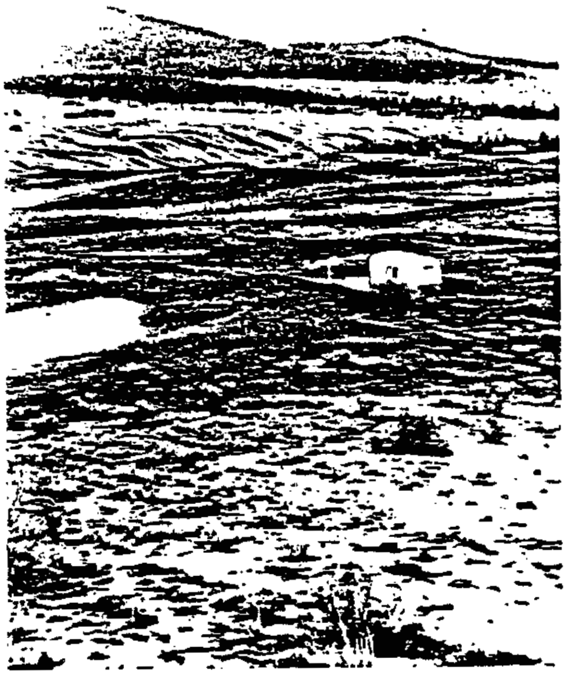
Noise from traffic on Highway 12 could be heard from vehicles which were at least one mile to the east of the site,however whenever traffic turned north at the Hat Creek junction the sound disappeared rapidly due to the shielding from high cliffs near the junction.

Other events included cows and birds. A small stream to the south of the site was audible during quiet periods.

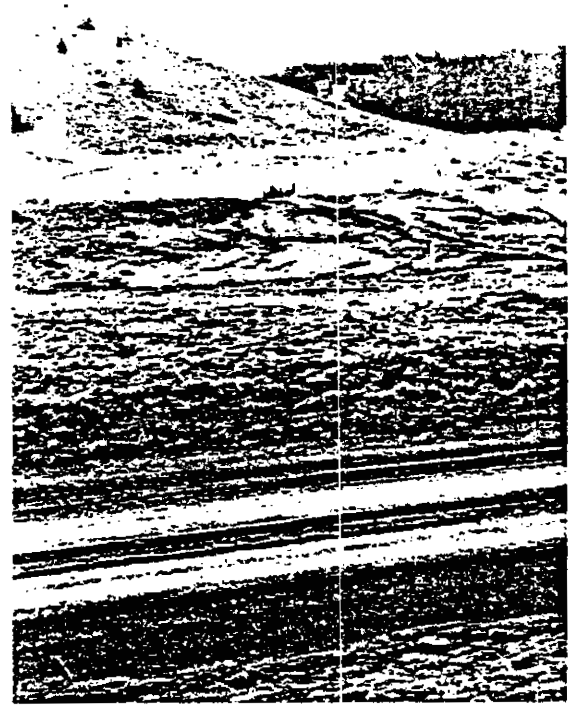
2.3-3 Site 3

Site 3 was located on the Hat Creek road approximately 7 miles south of the junction with Highway 12. It was situated at Hole 75-64 of the B.C. Hydro test drilling program. The site was in clear terrain overlooking the Hat Creek valley. Photographs of this site are contained in Figure 2.3-3a. The microphone was located approximately 200 feet from the Hat Creek Road as shown in Figure 2.3-3b. During the winter monitoring there were a few patches of crusty snow throughout the area and the ground was frozen.

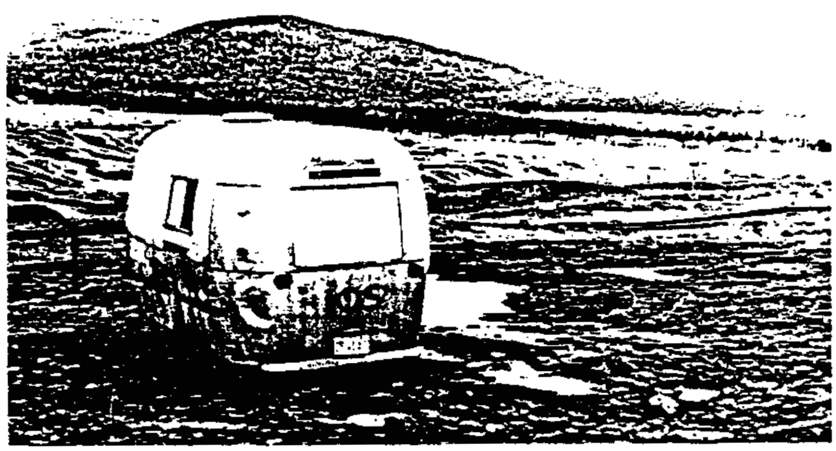
Most of the individual events were from isolated cars and trucks travelling along the road but these were relatively infrequent. Wind, which occurred on some of the monitoring days, was also a significant contributor to the noise events. Other events included cows, birds and the occassional light aircraft.



View looking N.W. at noise monitoring Lab with Hat Creek Road in background



View looking east across Hat Creek Road at noise monitor'ng lab.



Same view as above left.

Figure 2.3-3a: Site 3 Photographs

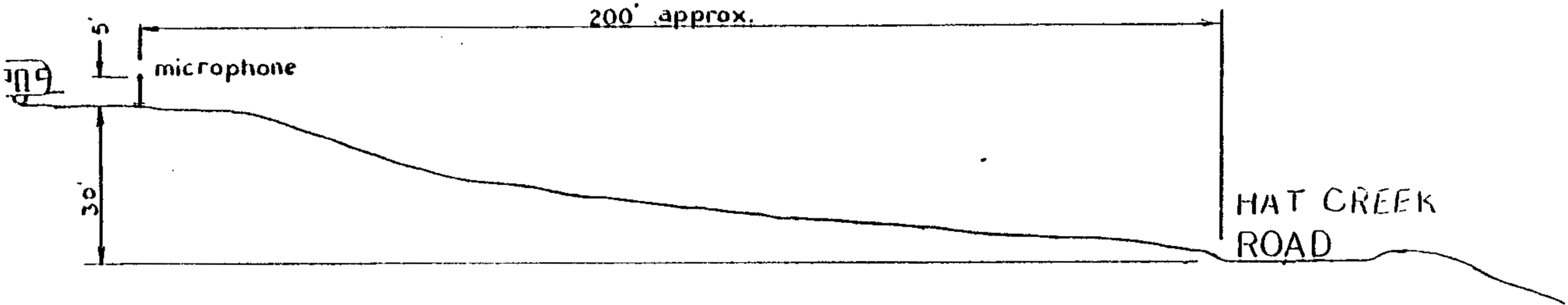


Figure 2.3-3b: Site 3 (not to scale)
Cross section as seen looking south.

2.3-4 Site 4

Site 4 was located ½ mile up the B.C. Hydro road which joins the Hat Creek road approximately 0.9 miles south of the junction with Highway 12. The site was near an open meadow but most of the surrounding area was wooded (see photographs in Figure 2.3-4). The microphone was located approximately 100 feet from the road. During the winter monitoring, patches of crusty snow existed throughout the area on the weekend monitoring (March 5, 1977) and a very light covering of fresh snow covered the area during the weekday monitoring (March 10, 1977).

Very little traffic occurs on the road (6 events in four days of monitoring) however during quiet periods traffic from Highway 12 is audible in the distance. On one day of monitoring wind accompanied by rain was the most signficant noise event.

2.4 Monitoring Schedule

At each site, two periods of 24 hour measurements were made during both the fall and winter monitoring programs; one on a weekday, and one on a weekend. Due to time lost in moving from one site to another, and in calibrating the system, some of the monitoring periods consisted of slightly less than 24 hours.

During the weekday winter monitoring at Site 1 on March 9, 1977 the microphone failed during the evening. Therefore the nighttime data was rejected and some redundant data obtained previously for a weeknight at this site was used in its place.

View looking N.W. at noise monitoring lab located at cattle gate on B.C. Hydro road.

View looking west at noise monitoring lab located on B.C. Hydro road

FIGURE 2.3-4: Site 4 Photographs

2.4 Monitoring Schedule (Cont'd)

On March 5, 1977 unmanned monitoring was conducted at site 4 to obtain data for a winter weekend. On this particular day it was unusually windy resulting in high peak noise levels. During occasional calm periods, however, the background noise level was extremely low. As a result, the dynamic range of the measurement system was insufficient and the instrumentation was overloaded during wind gusts. Hence, the data obtained was invalid. However, since this site was remote from man-made sound, the data obtained for a weekday is also indicative of a weekend at this location. Hence, repeat measurements were not made.

Table 2.4-1 indicates exactly what periods were monitored and Table 2.4-2 shows which of the periods monitored in the fall were manned and which were unmanned.

Site	From	To	Description
1	2:00 a.m. Oct. 26/76	12 Midnight Oct. 26/76	Fall-Weekday
	12 Midnight Oct. 22/76	12 Midnight Oct. 23/76	Fall-Weekend
	7 a.m. March 9/77 11:00 p.m. Feb. 10/77	7 p.m. March 9.77 7 a.m. Feb. 11/77	Winter-Weekday
	8:40 a.m. Feb. 20/77	5:40 a.m. Feb. 21/77	Winter-Weekend
2	12 Midnight Oct. 24/76	12 Midnight Oct. 25/76	Fall-Weekday
	2:00 a.m. Oct. 24/76	12 Midnight Oct. 24/76	Fall-Weekend
	8:00 a.m. Feb. 14/77	6:00 a.m. Feb. 15/77	Winter-Weekday
	8:00 a.m. March 6/77	6:00 a.m. March 7/77	Winter-Weekend
3	12 Midnight Oct. 28/76	12 Midnight Oct. 29/76	Fall-Weekday
	12 Midnight Oct. 29/76	12 Midnight Oct. 30/76	Fall-Weekend
	7:00 a.m. Feb. 18/77	6:00 a.m. Feb. 19/77	Winter-Weekday
	8:00 a.m. Feb. 19/77	6:00 a.m. Feb. 20/77	Winter-Weekend
4	12 Midnight Oct. 31/76	12 Midnight Nov. 1/76	Fall-Weekend
	12 Midnight Oct. 30/76	12 Midnight Oct. 31/76	Fall-Weekend
	8:00 a.m. March 10/77	6:00 a.m. March 11/77	Winter-Weekday
	-	-	Winter-Weekend

Table 2.4-1: Monitoring Schedule

	24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Oct. 23/76 Site 1	0	0	0	0	0	0	0	0	X	X	X	X	0	0	X	X	X	X	0	0	X	X	0	0
Oct. 24/76 Site 2	-	-	0	0	0	0	0	0	X	X	X	X	0	0	X	X	X	X	X	X	0	0	0	0
Oct. 25/76 Site 2	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	0	0	X	X	X	X
Oct. 26/76 Site 1	-	-	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	0	0	X	X	X	X
Oct. 29/76 Site 3	0	0	0	0	0	0	0	0	X	X	X	X	0	0	X	X	X	X	0	0	X	X	0	0
Oct. 30/76 Site 3	0	0	0	0	0	0	0	0	X	X	0	0	X	X	X	X	X	X	X	X	X	X	X	X
Oct. 31/76 Site 4	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nov. 1/76 Site 4	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X : manned

0 : unmanned

- : moving

Table 2.4-2: Fall Manning Schedule

2.5 Meteorological Conditions

During the fall monitoring, temperature, relative humidity and wind velocity were measured at the microphone location whenever conditions appeared to change significantly. The measurements were intended to reflect gross changes only since this data will not play a major role in the final evaluation of noise impact. The readings obtained are presented in Table 2.5-1.

During the winter monitoring, a random sampling of wind speed at the microphone was obtained on the tape recordings. When the tape recordings were played back, this wind speed data was observed to ensure that microphone wind noise was not significantly influencing the noise level data. Other meteorological data obtained from B. C. Hydro is presented in Table 2.5-2. Figure 2.5 shows the location of the B. C. Hydro weather monitoring stations which were used to provide this data. The weather station in closest proximity to a given noise monitoring location was used to provide meteorological data for that location as noted below.

Noise Monitoring Site	Closest Weather Monitoring Station
1	3
2	2
3	5
4	2

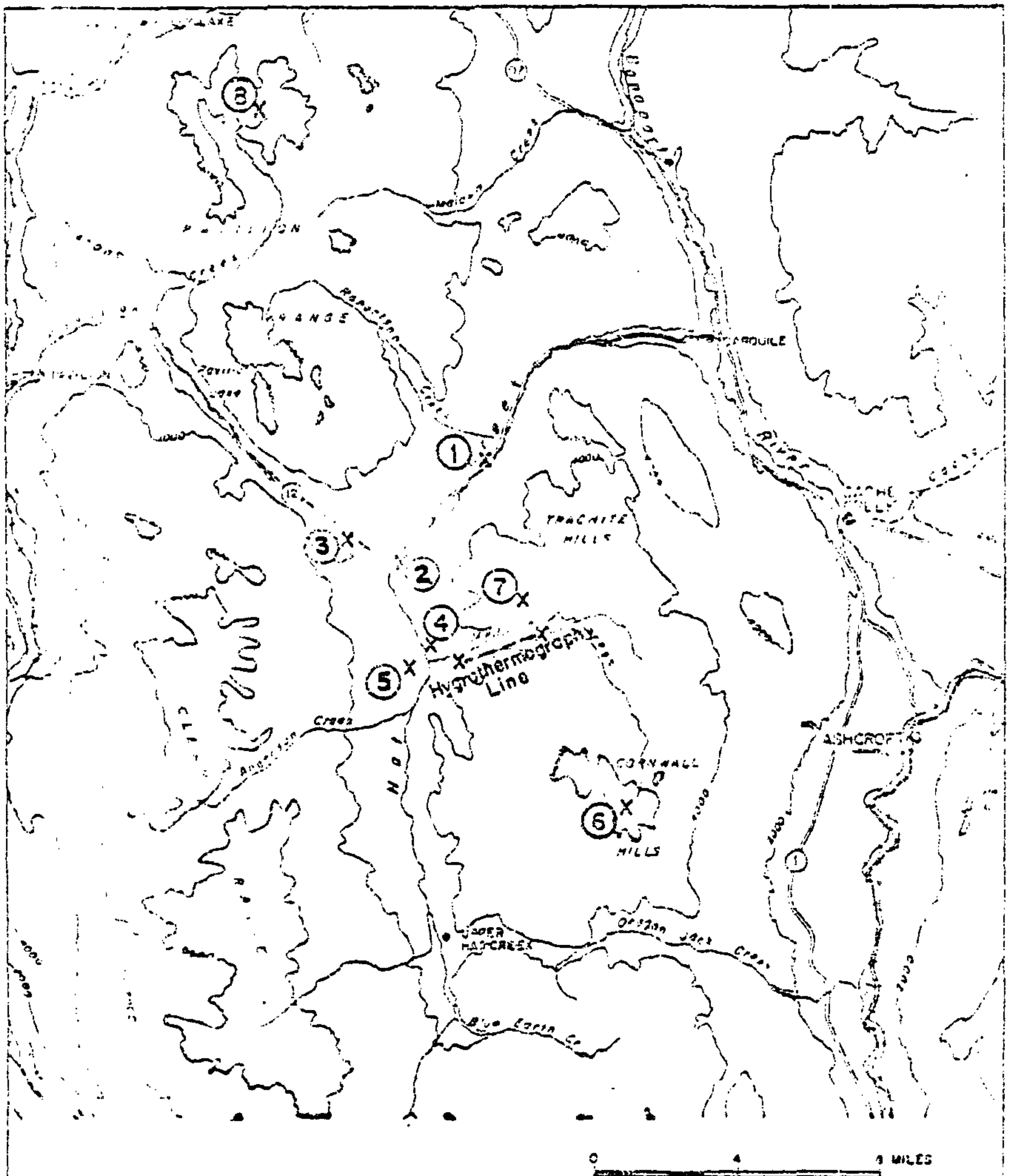


FIGURE 2.5

WEATHER AND HYGROTHERMOGRAPH MONITORING STATIONS

Site	Date	Time	Temperature °C	Relative Humidity (%)	Wind Speed (mph)	Wind Directior (°True)
1	Oct. 23	8:15			0	
		10:28			0	
		13:45	4	65		
		15:50			0	
		16:05	7	51		
		20:25	2	69	0	
		23:55	1	67	0	
	Oct. 26	9:22	0	73	0	
		12:46	8	64	0	
		20:16			0	
		21:50	5		0	
2	Oct. 24	8:00	0		0	
		13:55	5	73	1-2	52
		17:40	5	79	1-2	112
		19:20	5	73	0	
	Oct. 25	8:12	2.5	84	0	
		12:35	8	70	1-2	217
		13:07			5-10	212
		13:27			10	212
		14:40			1-2	
		15:23			10	42
		20:15	-1		0	
		22:45	-3		0	
3	Oct. 29	0:01	2	69	0	
		7:56	-1		5	152
		11:30			7-10	287
		11:50			7-10	292
		12:00			7-10	
		14:16			6	
		14:46			5	292

Table 2.5-1: *Meteorological Conditions During Fall Monitoring Periods*

NOISE MONITORING SITE	NEAREST B.C. HYDRO WEATHER STATION	DATE	TIME	TEMPERATURE °C	RELATIVE HUMIDITY %	WIND SPEED mph	WIND DIRECTI °true
2	2	Feb. 14	8:00	-7	89	1	V 190
			9:00	-6	88	2	170
			10:00	-1	74	1	V 190
			11:00	3	63	1	V 150
			12:00	4	45	5	90
			13:00	3	46	6	90
			14:00	4	45	5	90
			15:00	4	45	4	90
			16:00	3	47	2	V 100
			17:00	2	54	1	V 75
			18:00	0	64	1	45
			19:00	-1	73	1	100
			20:00	-2	81	1	95
			21:00	-2	84	1	95
			22:00	-3	86	1	100
			23:00	-3	87	3	245
			24:00	-3	87	2	V 270
		Feb. 15	1:00	-4	91	1	V 220
			2:00	-5	92	1	V 220
			3:00	-6	92	1	V 210
			4:00	-5	91	2	60
			5:00	-4	90	1	210
			6:00	-2	91	2	240
		Mar. 6	8:00	-4	90	1	155
			9:00	-3	86	1	V 155
			10:00	0	72	1	195
			11:00	3	53	2	195
			12:00	5	40	7	195
			13:00	5	38	6	210
			14:00	5	40	6	180
			15:00	5	37	9	210
			16:00	5	37	7	210
			17:00	5	35	7	200
			18:00	4	35	3	225
			19:00	2	41	4	300
			20:00	1	61	3	C 310
			21:00	-1	62	2	V 140
			22:00	-2	71	1	V 170
			23:00	-1	72	2	V 185
			24:00	-1	71	1	V 330
		Mar. 7	1:00	1	69	5	310
			2:00	2	69	3	320
			3:00	1	75	1	V 315
			4:00	-1	81	1	V 310
			5:00	-1	85	0	310
			6:00	-2	89	1	V 300

TABLE 2.5-2: METEOROLOGICAL CONDITIONS DURING WINTER MONITORING PERIODS

NOISE MONITORING SITE	NEAREST B.C. HYDRO WEATHER STATION	DATE	TIME	TEMPERATURE °C	RELATIVE HUMIDITY %	WIND SPEED mph	WIND DIRECTI °true
3	5	Feb. 18	7:00	-4	71	4	V 190
			8:00	-5	71	3	180
			9:00	-3	71	2	V 170
			10:00	-2	64	1	105
			11:00	1	56	2	C 100
			12:00	2	54	5	355
			13:00	2	61	6	355
			14:00	2	65	6	355
			15:00	3	66	4	360
			16:00	3	65	4	355
			17:00	2	67	3	355
			18:00	-1	79	2	360
			19:00	-2	85	3	V 340
			20:00	-2	84	6	V 280
			21:00	-3	84	4	210
			22:00	-3	84	5	200
			23:00	-3	84	2	220
			24:00	-4	85	2	V 205
		Feb. 19	1:00	-4	85	3	210
			2:00	-5	85	4	200
			3:00	-5	86	3	195
			4:00	-5	86	3	195
			5:00	-5	85	3	190
			6:00	-5	86	4	190
		Feb. 19	8:00	-5	86	2	180
			9:00	-3	87	2	195
			10:00	-2	82	2	V 185
			11:00	0	77	1	V 230
			12:00	0	76	2	V 100
			13:00	1	76	2	45
			14:00	2	72	2	40
			15:00	3	62	3	V 30
			16:00	4	54	2	C 25
			17:00	3	54	1	V 345
			18:00	2	63	1	330
			19:00	0	76	3	V 350
			20:00	0	80	5	V 290
			21:00	-1	79	3	205
			22:00	-1	79	3	190
			23:00	-1	80	3	190
			24:00	-1	80	4	190
		Feb. 20	1:00	-1	81	2	190
			2:00	-2	82	5	195
			3:00	-2	82	6	195
			4:00	-2	82	4	V 225
			5:00	-2	82	3	205
			6:00	-2	82	4	V 220

TABLE 2.5-2: METEOROLOGICAL CONDITIONS DURING WINTER MONITORING PERIODS

Site	Date	Time	Temperature °C	Relative Humidity (%)	Wind Speed (mph)	Wind Direction (°True)
3	Oct. 29	16:14			5	292
		20:18	0	74	3-5	152
	Oct. 30	0:30	0	82	0	
		11:20	6	43	10	267
		11:58			12	187
		12:46			18	142
		16:24			15	142
		17:40	5.5	49	5	190
		19:07			0	
		19:47			10	367
		20:50			11	182
		22:00			5	
		23:03	5	59	0	
4	Oct. 31	0:30	0.5	75	0	
		8:40			0	
		9:20	7	63	< 5	
		10:20			5-7	102
		11:58			7-10	172
		15:00	9	54	5-7	167
		15:53			10-12	107
		16:20			0	
		20:12	6.5	33	< 5	
	Nov. 1	0:20	-2		0	
		8:40	-2		0	
		12:09			0	
		14:35	6.5	38	0	
		18:25			0	
		19:00	0	65		
		23:30	-2		0	

Table 2.5-1: Meteorological Conditions During Fall Monitoring Periods

NOISE MONITORING SITE	NEAREST B.C. HYDRO WEATHER STATION	DATE	TIME	TEMPERATURE °C	RELATIVE HUMIDITY %	WIND SPEED mph	WIND DIRECTION °true
1	3	Feb. 20	8:00	-2	96	9	60
			9:00	-2	94	8	65
			10:00	0	90	7	65
			11:00	2	82	7	65
			12:00	3	72	5	75
			13:00	6	61	2	90
			14:00	8	55	3	45
			15:00	10	51	3	35
			16:00	10	47	4	45
			17:00	9	47	4	55
			18:00	8	53	3	60
			19:00	7	61	4	50
			20:00	5	70	3	50
			21:00	3	79	1	50
			22:00	3	83	3	45
			23:00	3	85	2	75
			24:00	1	93	2	60
		Feb. 21	1:00	1	72	4	60
			2:00	2	51	3	275
			3:00	0	62	2	V 275
			4:00	-3	73	1	C 320
			5:00	-3	81	5	55
			6:00	-3	81	5	60
		Feb. 10	23:00	2	92	2	C 50
			24:00	1	93	1	195
		Feb. 11	1:00	1	95	1	185
			2:00	0	94	1	C 185
			3:00	-1	94	2	285
			4:00	-2	94	1	275
			5:00	-3	93	1	275
			6:00	-3	93	1	C 275
			7:00	-3	93	2	30
		March 9	7:00	-7	89	2	45
			8:00	-7	81	2	45
			9:00	-5	61	2	C 25
			10:00	-1	45	3	V 235
			11:00	2	40	7	235
			12:00	4	37	6	235
			13:00	5	34	6	240
			14:00	6	31	7	255
			15:00	6	34	7	245
			16:00	5	41	7	245
			17:00	5	45	6	245
			18:00	4	47	2	255
			19:00	2	55	0	255

V=Variable
C=Changing

TABLE 2.5.-2: METEOROLOGICAL CONDITIONS DURING WINTER MONITORING PERIODS

NOISE MONITORING SITE	NEAREST B.C. HYDRO WEATHER STATION	DATE	TIME	TEMPERATURE °C	RELATIVE HUMIDITY %	WIND SPEED mph	WIND DIRECTIO °true
4	2	Mar. 10	8:00	-7	91	1	40
			9:00	-5	79	2	C 35
			10:00	-1	55	2	V 360
			11:00	2	34	3	315
			12:00	4	14	6	235
			13:00	5	5	6	240
			14:00	6	5	5	240
			15:00	6	6	6	240
			16:00	5	11	4	230
			17:00	5	18	3	C 255
			18:00	4	30	3	C 15
			19:00	2	42	2	C 360
			20:00	1	51	1	35
			21:00	1	56	2	25
			22:00	1	56	2	45
			23:00	1	57	2	35
			24:00	1	57	2	C 45
		Mar. 11	1:00	1	58	1	C 355
			2:00	1	59	2	45
			3:00	-1	62	3	50
			4:00	-1	67	3	45
			5:00	-1	67	4	50
			6:00	-1	65	3	45

TABLE 2.5-2: METEOROLOGICAL CONDITIONS DURING WINTER MONITORING PERIODS

3.0 RESULTS

The following sections present the data obtained in terms of various statistical indices, L_i, where L_i is the noise level in dBA (fast response) exceeded i% of the time and also in terms of the equivalent sound level, $Leq_{(24)}$ and day/night equivalent sound level, Ldn.

3.1 Statistical Indices

The statistical indices computed by the General Radio 1945 Community Noise Analyser are presented for day, night and 24 hour (day/night combined) periods. Day is defined as the hours between 7:00 a.m. and 10:00 p.m. and night is defined as the hours between 10:00 p.m. and 7:00 a.m. During the fall monitoring, the 24 hour day was defined rather arbitrarily as the hours between midnight and the following midnight. (i.e. corresponding to a calendar day). During the winter monitoring however, the 24 hour day was defined as the hours between 7:00 a.m. and 7:00 a.m. the following day. There were two reasons for this change. The first was that unmanned monitoring could be done more efficiently with the available equipment if the beginning of the 24 hour day coincided with the beginning of the 15 hour day (i.e. 7:00 a.m. to 10:30 p.m. as opposed to the night time period). Secondly, this later definition of the 24 hour day more closely resembles our subjective conception of a day.

Whenever it was necessary to miss an hour or two of monitoring to change locations or calibrate the equipment, it was assumed that the period missed would be similar to the monitoring period from which it was omitted. Therefore the statistics obtained for day, night and combined day/night periods would not be significantly affected by the missing data.

3.1 Statistical Indices (cont'd)

The equipment utilized for the monitoring was not capable of storing statistical data for the entire 24 hour day in addition to portions of the day. Therefore it was necessary to combine statistics obtained for portions of a day in order to derive statistical indices which would apply to the entire 24 hours. This was done by numerically averaging the values for the portions of the day taking into account the durations of the periods being combined. For example if $L_{i\ (9\ hrs.)}$ and $L_{i\ (15\ hrs.)}$ were to be combined to give $L_{i(24\ hrs)}$ the following formula was used:

$$(9/24)\ L_{i(9\ hrs.)} + (15/24)L_{i(15\ hrs.)} \approx L_{i(24\ hrs.)}$$

The accuracy of this approximation depends upon the similarity between the shapes of the two statistical distribution functions. The results are most accurate when combining statistics derived from similar distribution functions.

The statistical indices computed include the $L_{0.1}$, L_1, L_2, L_5, L_{10}, L_{20}, L_{50}, L_{90} and L_{99}. The L_{10}, L_{50} and L_{90} values are summarized in Tables 3.1-1, 3.1-2, and 3.1-3 respectively. Cumulative distributions derived from all of the statistical indices obtained are presented for each site both in fall and in winter (see Figures 3.1-1 to 3.1-8).

Site	Time of Day	Fall		Winter	
		Weekday	Weekend	Weekday	Weekend
1	day	42	39	44	43
	night	30	27	37	36
	24 hrs.	37	35	41	40
2	day	46	42	43	41
	night	35	34	34	32
	24 hrs.	42	39	40	38
3	day	26	36	24	24
	night	23	24	23	29
	24 hrs.	25	32	24	26
4	day	27	40	29	-
	night	25	27	25	-
	24 hrs.	26	35	28	-

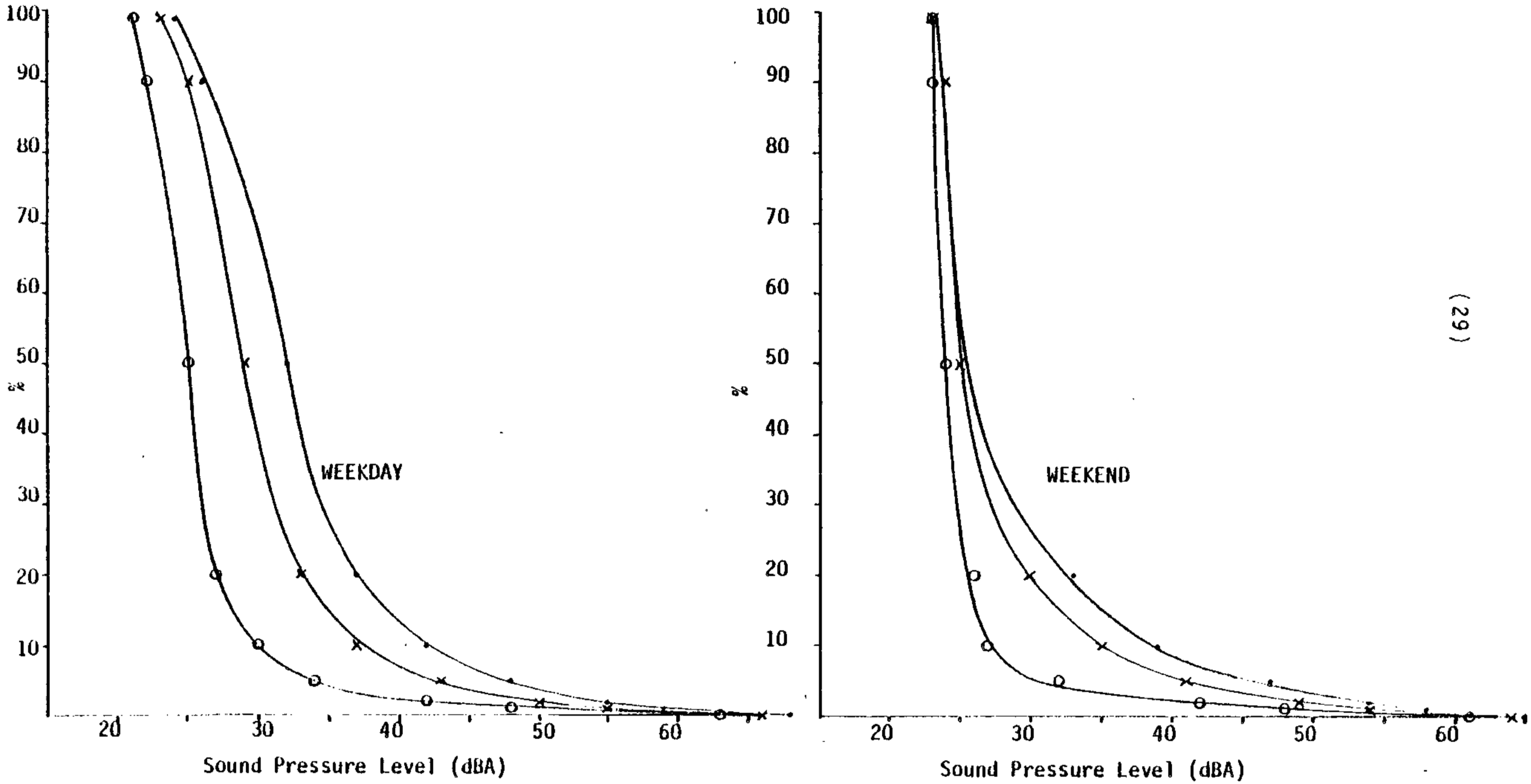
TABLE 3.1-1: Measured Values of L_{10} (dBA)

Site	Time of Day	Fall		Winter	
		Weekday	Weekend	Weekday	Weekend
1	day	32	25	35	29
	night	25	24	32	30
	24 hrs.	29	25	34	29
2	day	33	33	28	33
	night	32	33	28	30
	24 hrs.	33	33	28	32
3	day	21	31	19	19
	night	22	23	20	20
	24 hrs.	21	28	19	19
4	day	22	33	21	-
	night	22	25	19	-
	24 hrs.	22	30	20	-

TABLE 3.1-2 Measured Values of L_{50} (dBA)

Site	Time of Day	Fall		Winter	
		Weekday	Weekend	Weekday	Weekend
1	day	26	24	26	24
	night	22	23	29	25
	24 hrs.	25	24	27	24
2	day	31	32	27	29
	night	31	32	27	29
	24 hrs.	31	32	27	29
3	day	18	28	18	18
	night	21	22	19	19
	24 hrs.	19	26	18	18
4	day	21	29	18	-
	night	21	25	18	-
	24 hrs.	21	28	18	-

TABLE 3.1-3: Measured Values of L_{90} (dBA)



• Day
o Night
× 24 hrs.

Figure 3.1-1: Site 1 - Fall, Cumulative Distributions of Excedence Levels for Day, Night and 24 hours

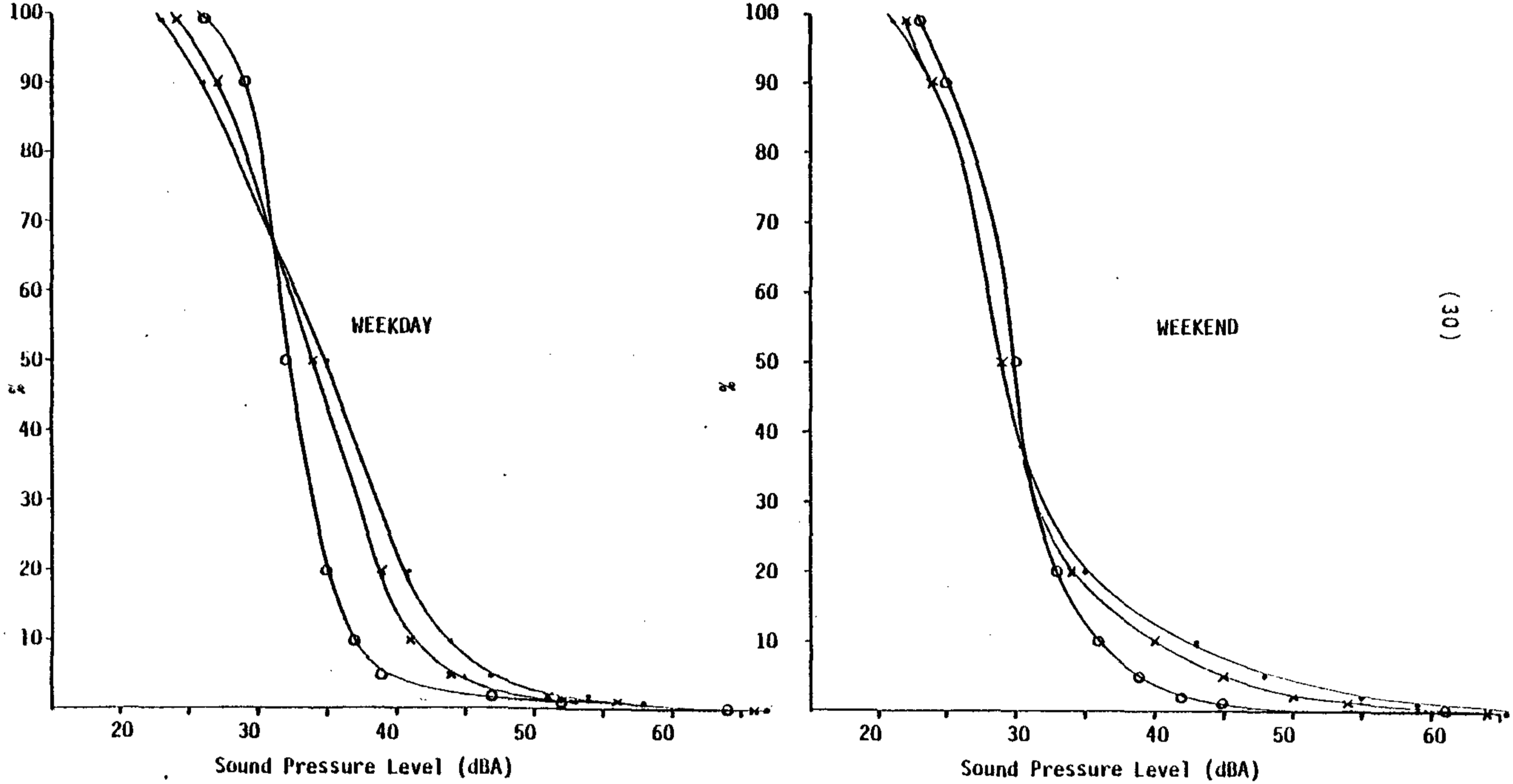
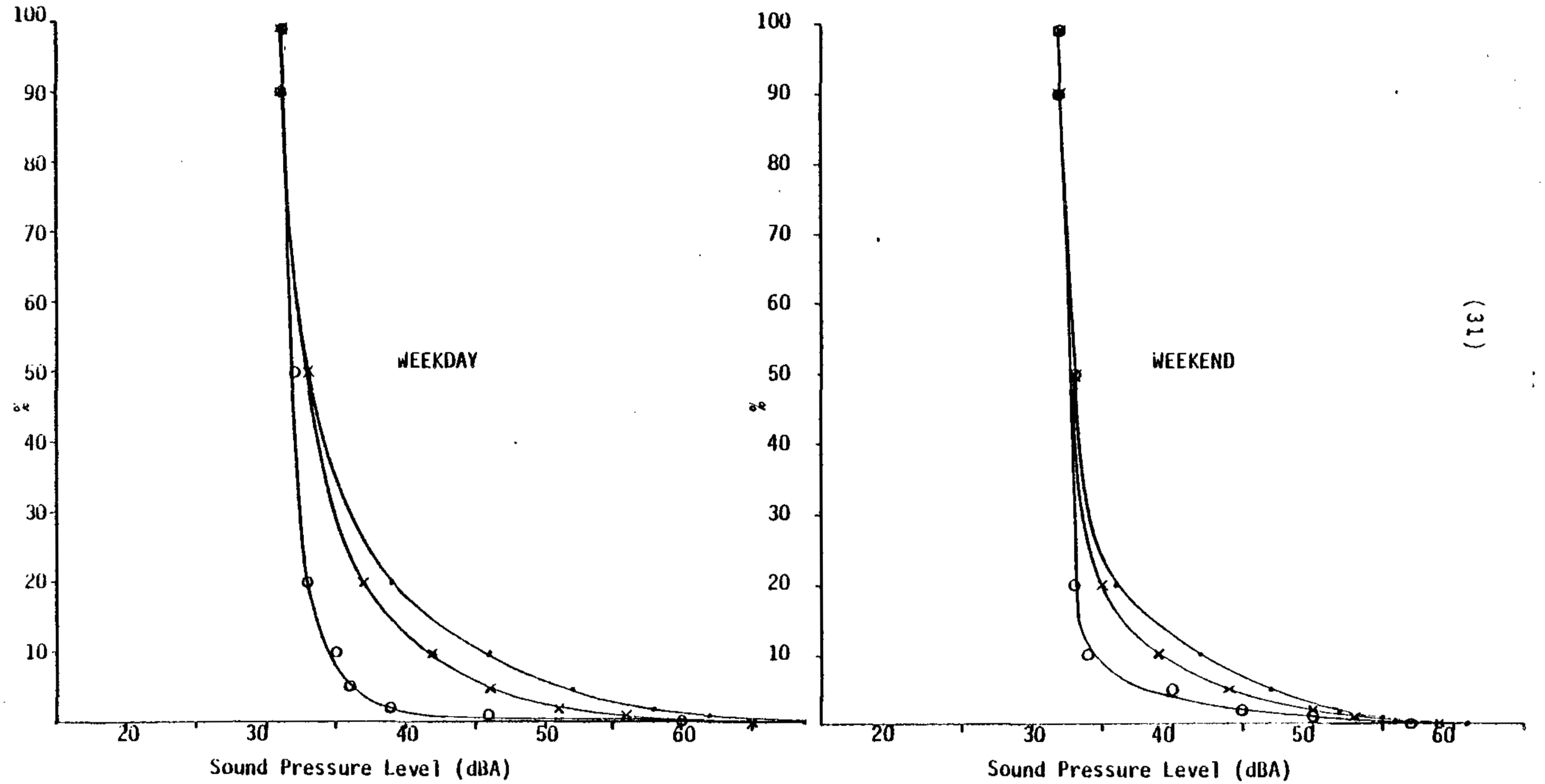
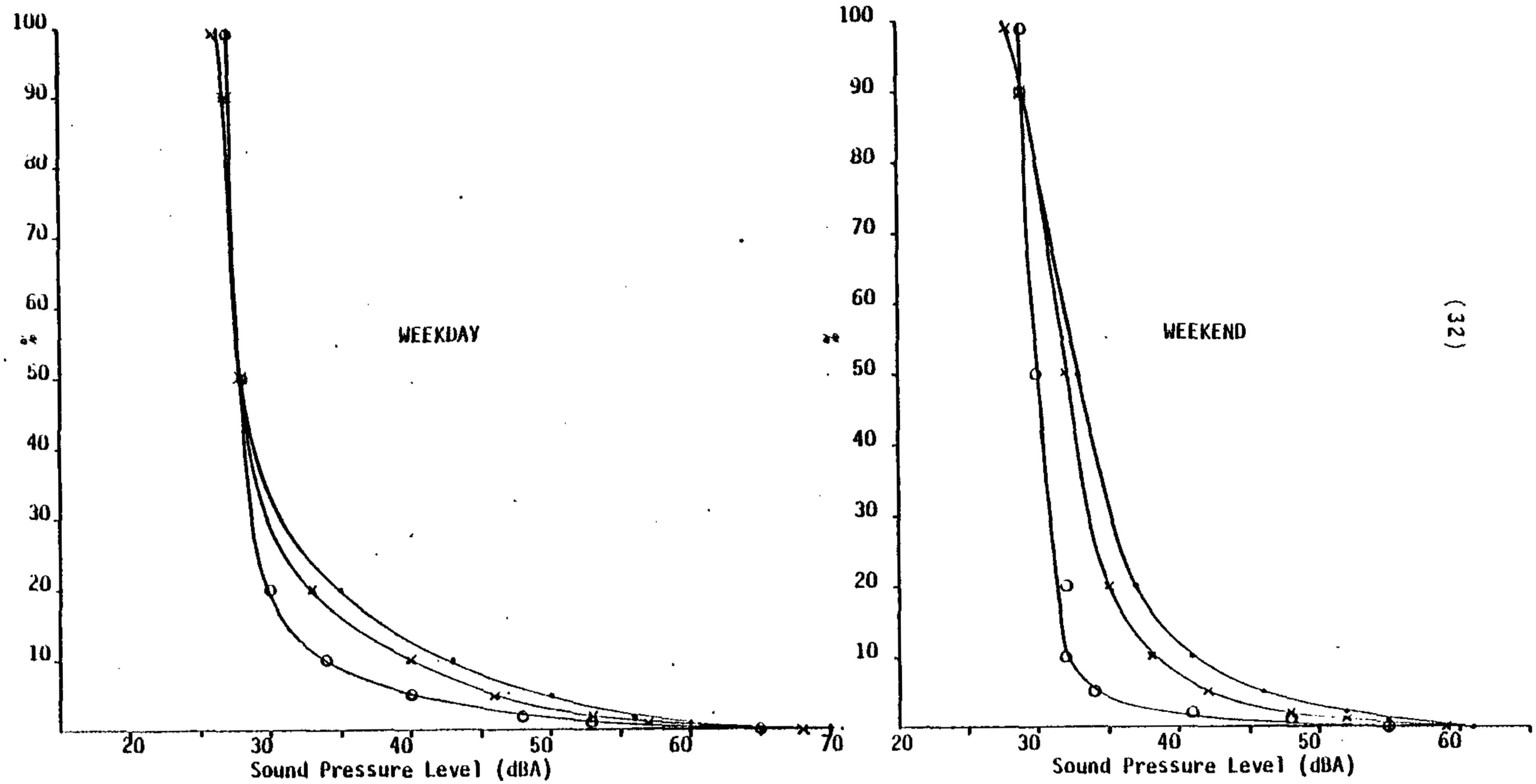


Figure:3.1-2: Site 1 -Winter, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours.



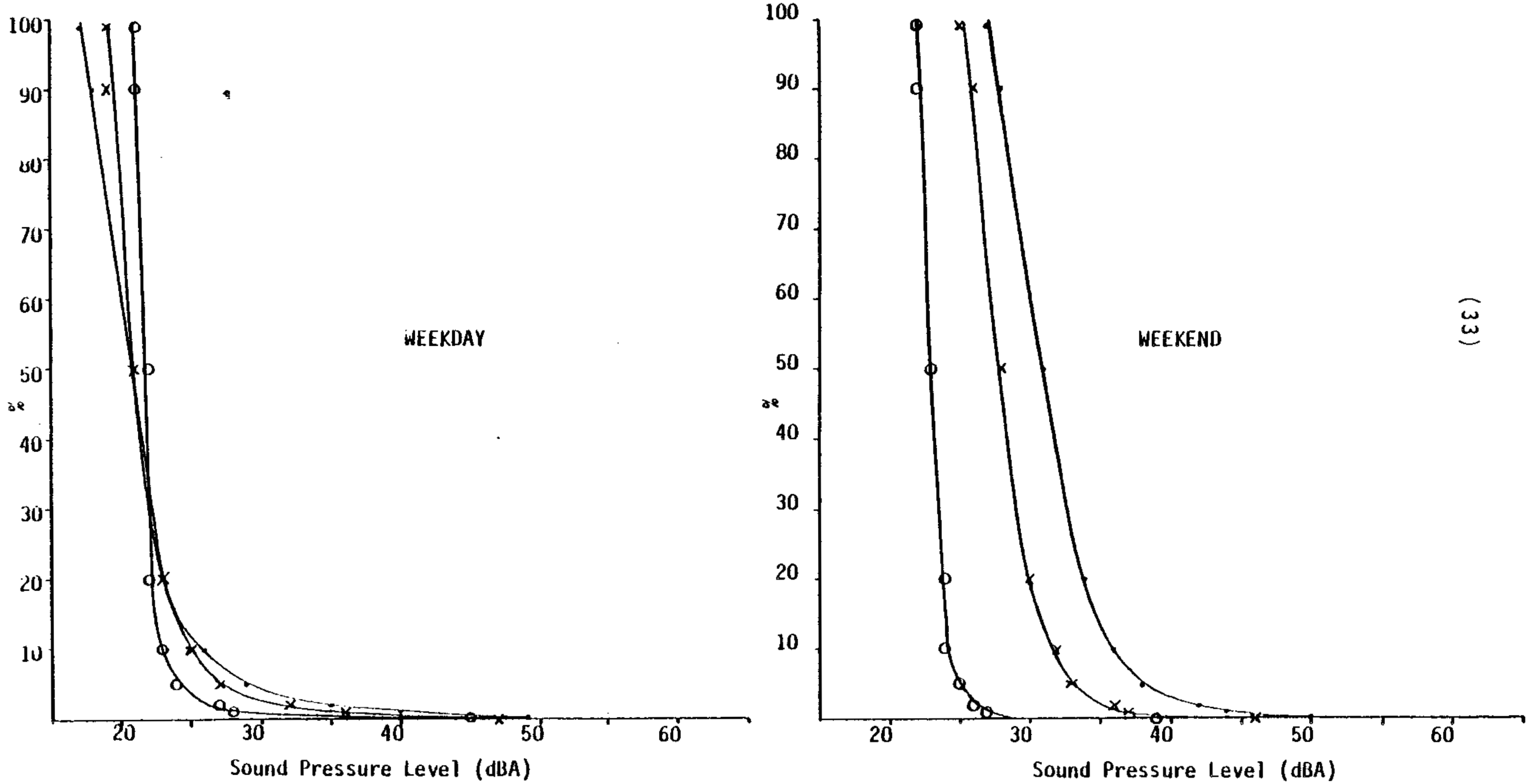
- · Day
- o Night
- x 24 Hrs.

Figure 3.1-3: Site 2 - Fall, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours.



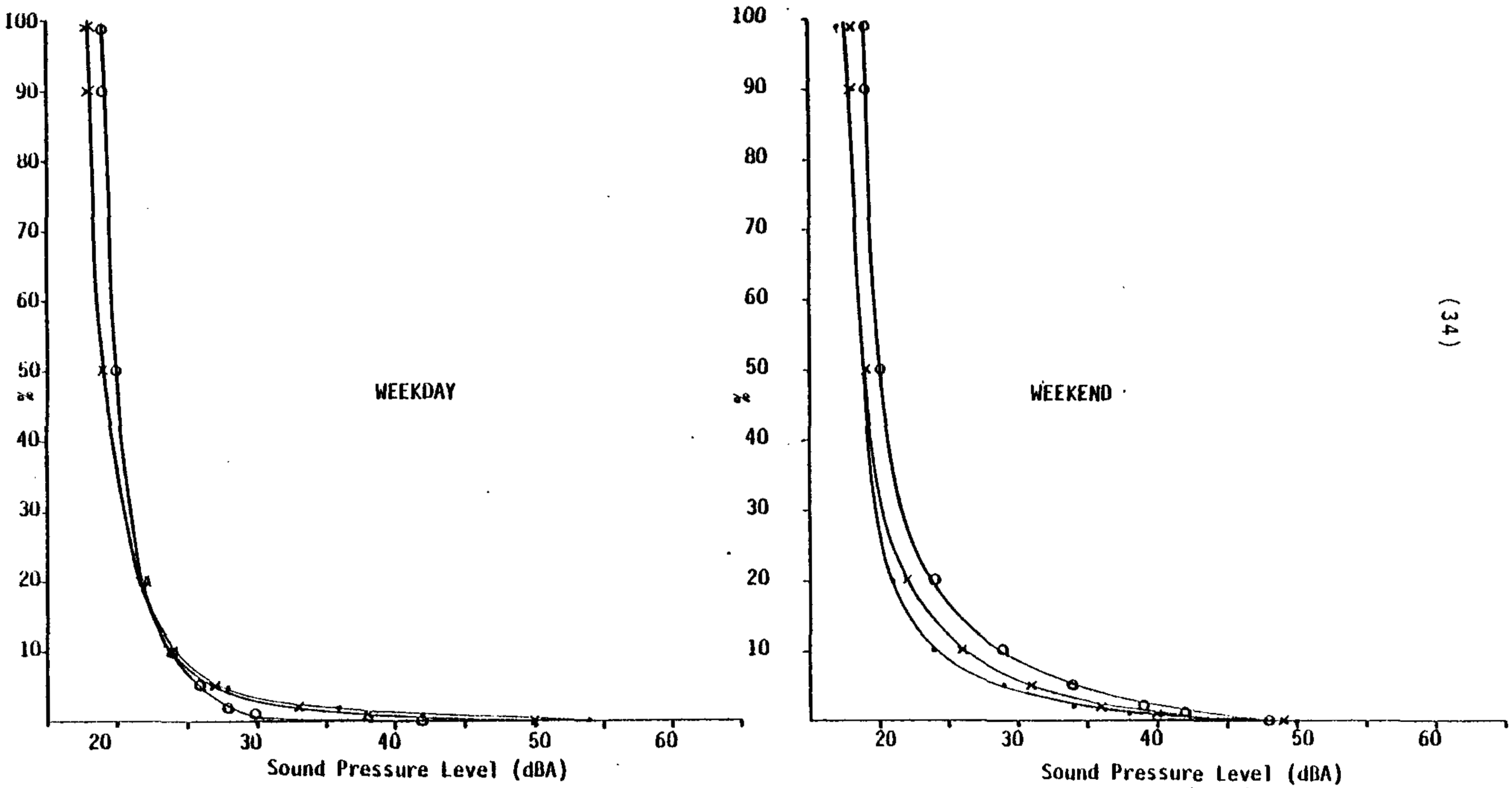
• Day
o Night
x 24 Hrs.

Figure 3.1-4: Site 2 - Winter, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours.



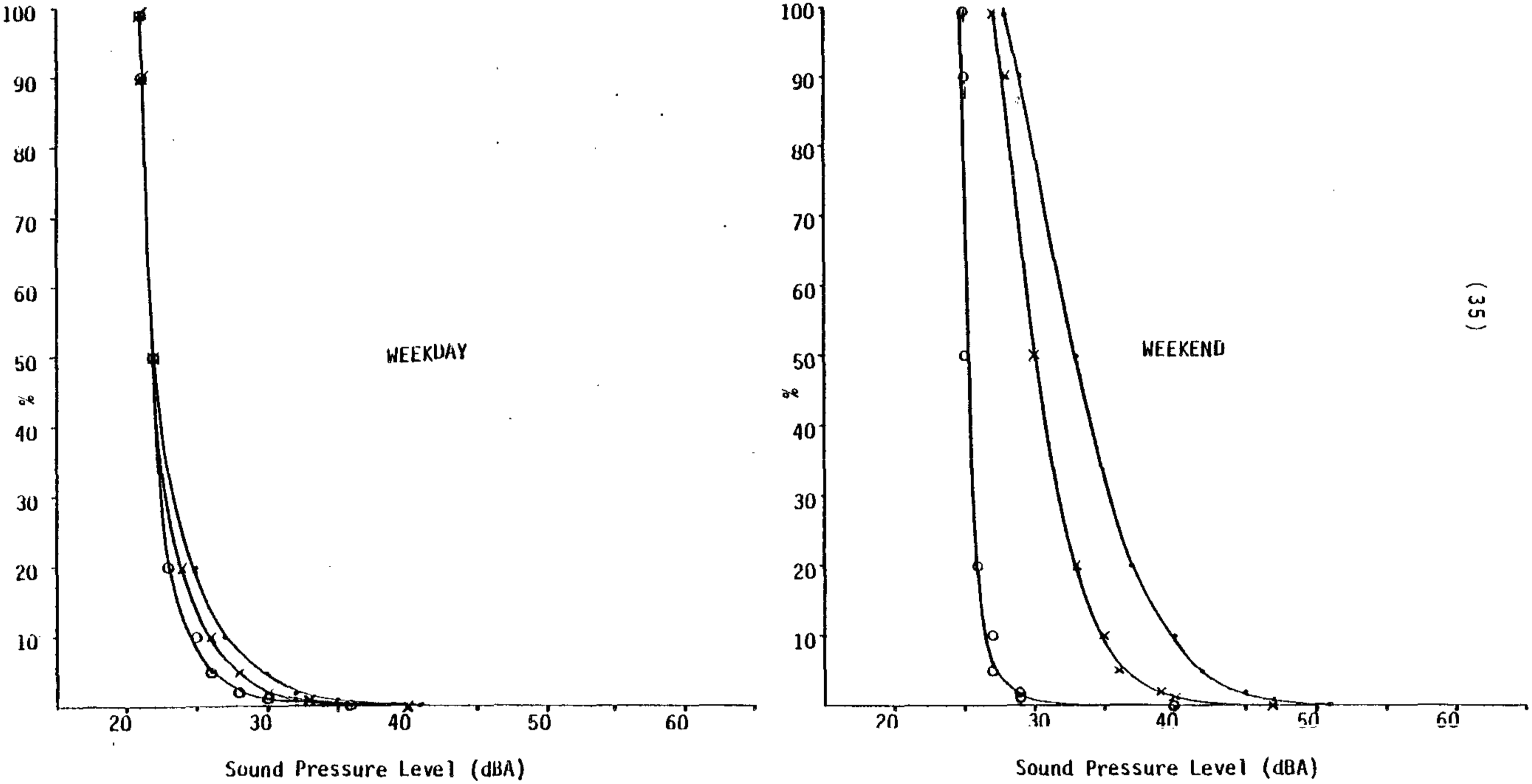
• Day
o Night
x 24 Hrs.

Figure: 3.1-5: Site 3- Fall, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours



· Day
o Night
× 24 hrs.

Figure 3.1-6: Site 3 - Winter, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours.



• Day
o Night
x 24 Hrs.

Figure 3.1-7: Site 4 - Fall, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours

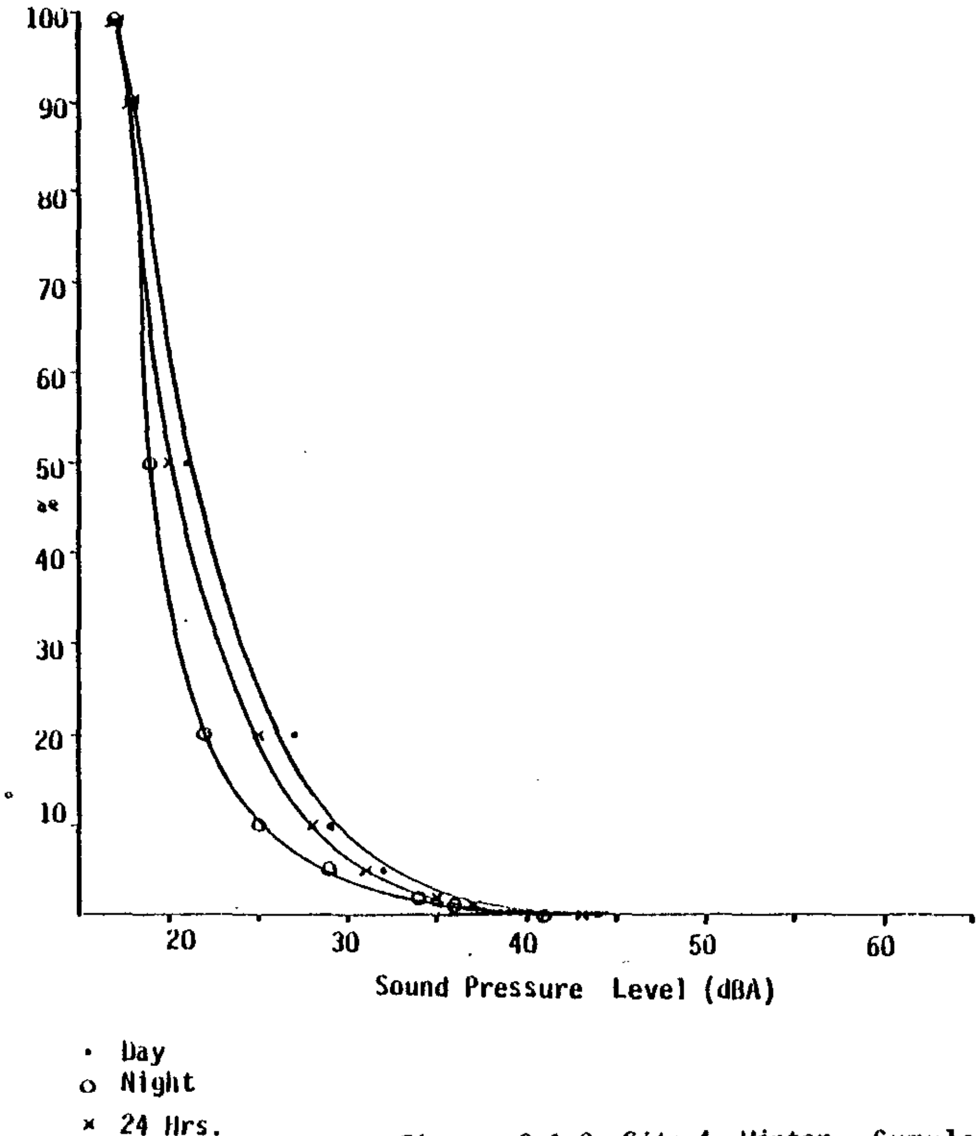


Figure: 3.1-8: Site 4- Winter, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours

3.2 Equivalent Energy Descriptors (Leq and Ldn)

The Leq or equivalent sound level represents the steady A-weighted sound level which would contain the same sound energy over a specified period of time as the actual time-varying sound level over that time. The $Leq_{(24)}$ is the equivalent sound level over a 24 hour period.

The Ldn or day/night equivalent sound level is similar to the $Leq_{(24)}$ except that a night time weighting factor of 10 dB is applied to the hours between 10:00 p.m. and 7:00 a.m. in order to reflect the greater annoyance caused by noises during this period. This noise descriptor is widely accepted as being the community noise index which best relates to public health and welfare (including considerations ranging from hearing damage to subjective annoyance).

As discussed previously in Section 3.1, it has been necessary to combine data obtained for portions of a day to provide values which apply to an entire 24 hour day. Values of Leq were combined according to the formula below.

$$Leq = 10 \log \left[\frac{D_1 \log^{-1} \left(\frac{Leq_1}{10}\right) + D_2 \log^{-1} \left(\frac{Leq_2}{10}\right)}{D_1 + D_2} \right] \text{ dB}$$

where:

D_1 = duration of period #1

D_2 = duration of period #2

Leq_1 = Leq for period #1

Leq_2 = Leq for period #2

Leq = Leq for periods #1 and #2 combined

3.2 Equivalent Energy Descriptors (Leq and Ldn) (cont'd)

The formula used to compute Ldn is given below:

$$Ldn = 10 \log \frac{1}{24} \left[15 \left(10^{Ld/10}\right) + 9 \left(10^{\frac{Ln + 10}{10}}\right) \right] \text{ dB}$$

where:

Ld = Leq for day time period 0700 - 2200
Ln = Leq for night time period 2200 - 0700
Ldn = day/night equivalent sound level

The values of $Leq_{(24)}$ and Ldn obtained at each site during the fall and winter monitoring sessions are presented in Table 3.2.

3.3 Traffic Logs

Traffic counts were obtained for both day and night during the monitoring periods. Data for the day, night and entire day is presented in Tables 3.3-1, 3.3-2, and 3.3-3 respectively. These were obtained by the field engineer during the manned monitoring and by listening to tape recordings which were made during the unmanned monitoring periods. Where necessary on account of gaps in the data, traffic counts were normalized to 15 hours for daytime periods and to 9 hours for nighttime periods.

3.4 Octave Band Data

The octave band spectra presented on the following pages (Figures 3.4-1 to 3.4-8) indicate the range of background levels that were measured at various times of day during the fall and winter monitoring periods.

SITE	:	FALL WEEKDAY	FALL WEEKEND	WINTER WEEKDAY	WINTER WEEKEND
1	Ld	48	45	46	46
	Ln	42	38	42	38
	$Leq_{(24)}$	47	43	45	44
	Ldn	50	46	49	47
2	Ld	50	43	48	43
	Ln	42	39	42	35
	$Leq_{(24)}$	48	41	47	41
	Ldn	51	46	50	44
3	Ld	30	37	31	28
	Ln	26	25	24	29
	$Leq_{(24)}$	29	35	29	28
	Ldn	33	36	32	35
4	Ld	34	42	27	--
	Ln	24	27	25	--
	$Leq_{(24)}$	32	40	26	--
	Ldn	34	41	32	--

Ld - day average sound level.
Ln - night average sound level.
$Leq_{(24)}$ - 24 hour average sound level.
Ldn - day-night average sound level.

Table 3.2: Values of Ld, Ln, $Leq_{(24)}$, and Ldn

SITE	MONITORING PERIOD	CARS	TRUCKS	TOTAL	% TRUCKS
1	Fall Weekday	111	76	187	41
	Fall Weekend	151	44	195	23
	Winter Weekday	159	22	181	12
	Winter Weekend	168	22	190	12
2	Fall Weekday	176	105	281	37
	Fall Weekend	126	59	185	32
	Winter Weekday	113	28	141	20
	Winter Weekend	97	8	105	8
3	Fall Weekday	18	8	26	31
	Fall Weekend	16	2	18	11
	Winter Weekday	4	0	4	0
	Winter Weekend	5	1	6	17
4	Fall Weekday	5	0	5	0
	Fall Weekend	1	0	1	0
	Winter Weekday	0	0	0	0
	Winter Weekend	0	0	0	0

TABLE 3.3-1: Daytime Traffic Log (15 hours)

SITE	MONITORING PERIOD	CARS	TRUCKS	TOTAL	% TRUCKS
1	Fall Weekday	26	10	36	28
	Fall Weekend	23	10	33	30
	Winter Weekday	17	2	19	10
	Winter Weekend	12	3	15	20
2	Fall Weekday	27	9	36	25
	Fall Weekend	19	2	21	10
	Winter Weekday	8	7	15	47
	Winter Weekend	16	0	16	0
3	Fall Weekday	5	2	1	29
	Fall Weekend	1	0	1	0
	Winter Weekday	0	0	0	0
	Winter Weekend	1	0	1	0
4	Fall Weekday	0	0	0	0
	Fall Weekend	0	0	0	0
	Winter Weekday	0	0	0	0
	Winter Weekend	0	0	0	0

TABLE 3.3-2: Nighttime Traffic Log (9 hours)

SITE	MONITORING PERIOD	CARS	TRUCKS	TOTAL	% TRUCKS
1	Fall Weekday	137	86	223	39
	Fall Weekend	174	54	228	24
	Winter Weekday	176	24	200	12
	Winter Weekend	180	25	205	12
2	Fall Weekday	203	114	317	36
	Fall Weekend	145	61	206	30
	Winter Weekday	121	35	156	22
	Winter Weekend	113	8	121	7
3	Fall Weekday	23	10	33	30
	Fall Weekend	17	2	19	11
	Winter Weekday	4	0	4	0
	Winter Weekend	6	1	7	14
4	Fall Weekday	5	0	5	0
	Fall Weekend	1	0	1	0
	Winter Weekday	0	0	0	0
	Winter Weekend	0	0	0	0

TABLE 3.3- 3: Traffic Log for Entire Day (24 hours)

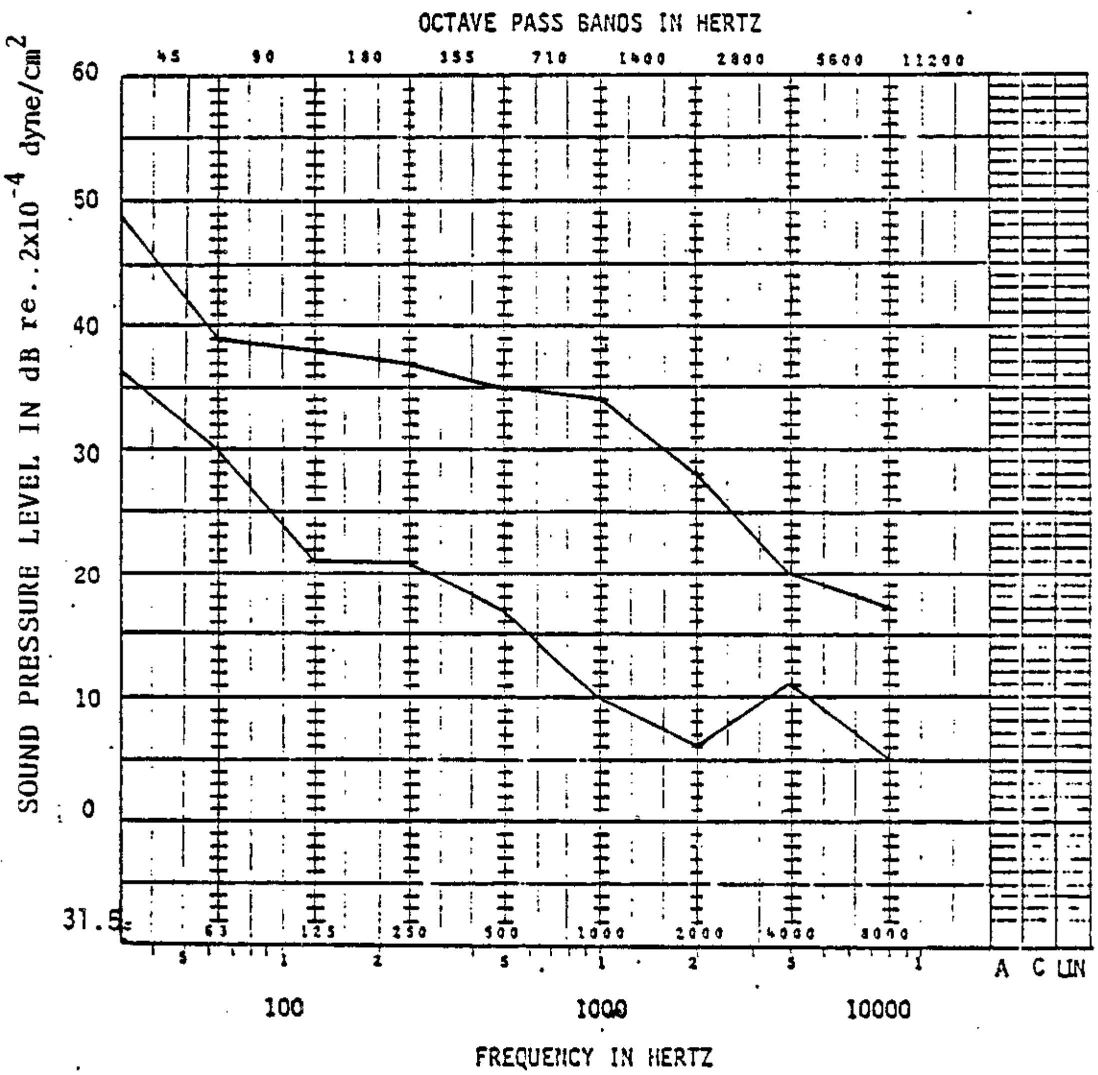
date	time	by	file	P
Oct. '76			72-161-2	1 OF 8

description

Figure 3.4-1: Site 1 - Fall

20 - 32.5 dBA

Upper Curve - Maximum Sound Pressure Levels Measured
Lower Curve - Minimum Sound Pressure Levels Measured

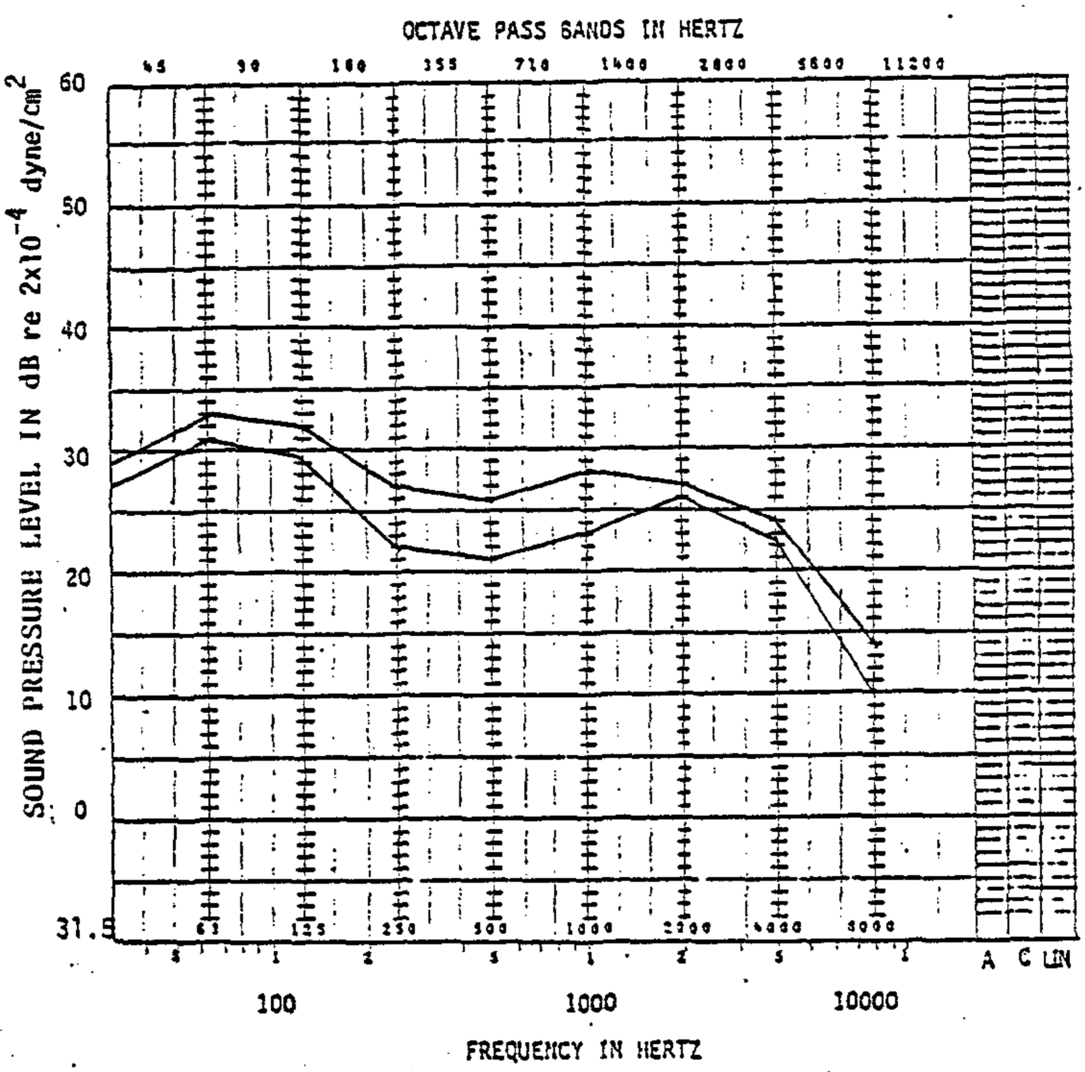


date	time	by	file	p
Oct. '76			7 2-161-2	2 OF 8

description

Figure 3.4-2: Site 2 - Fall
31.5 - 32.5 dBA

Upper Curve - Maximum Sound Pressure Levels Measured
Lower Curve - Minimum Sound Pressure Levels Measured

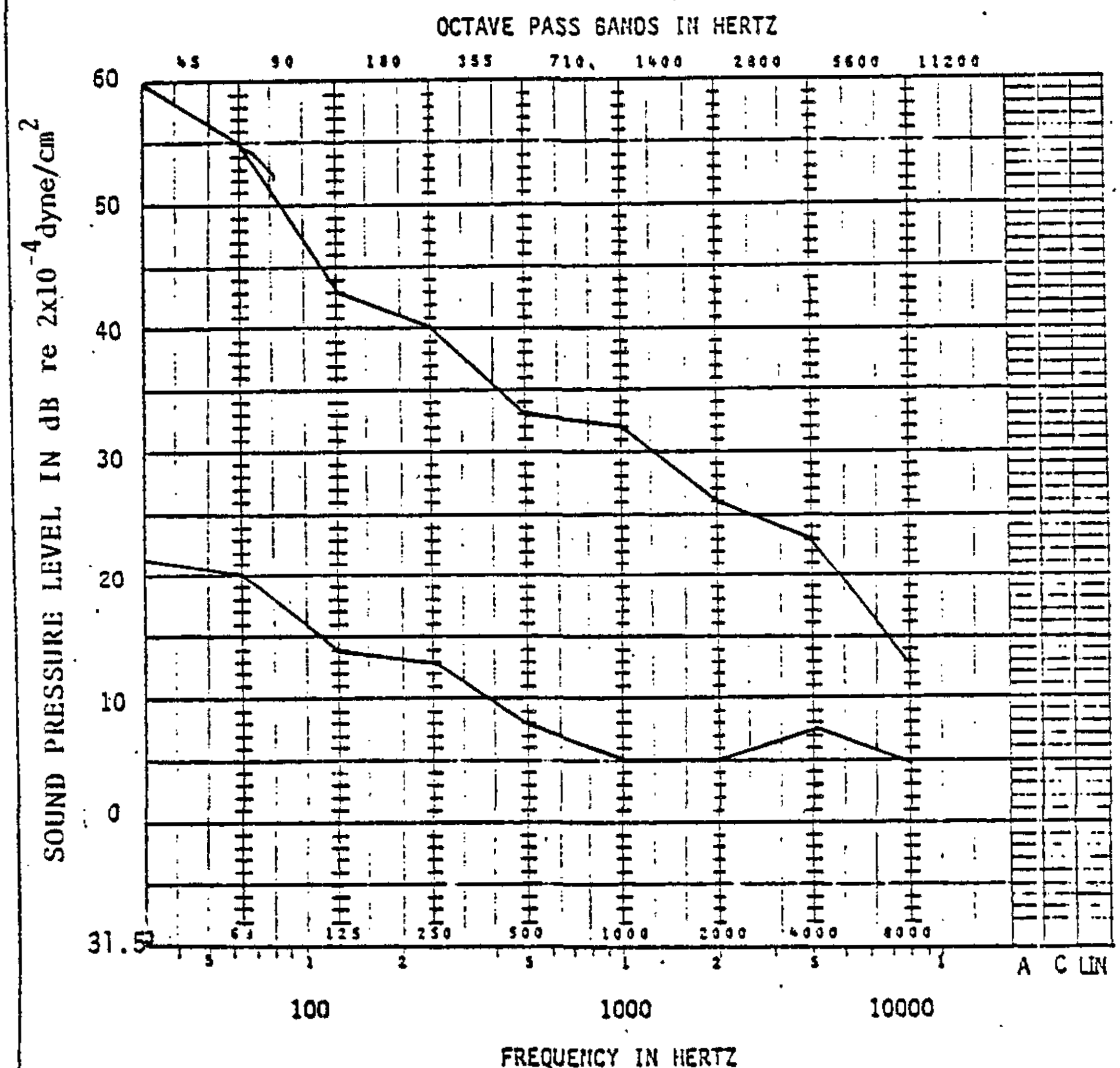


date	time	by	file	p 3 OF 8
Oct. '76			72-161-2	

description

Figure 3.4-3: Site 3 - Fall
15 - 44 dBA

Upper Curve - Maximum Sound Pressure Levels Measured
Lower Curve - Minimum Sound Pressure Levels Measured



date	time	by	file	P 4 OF 8
Oct. '76			72-161-2	

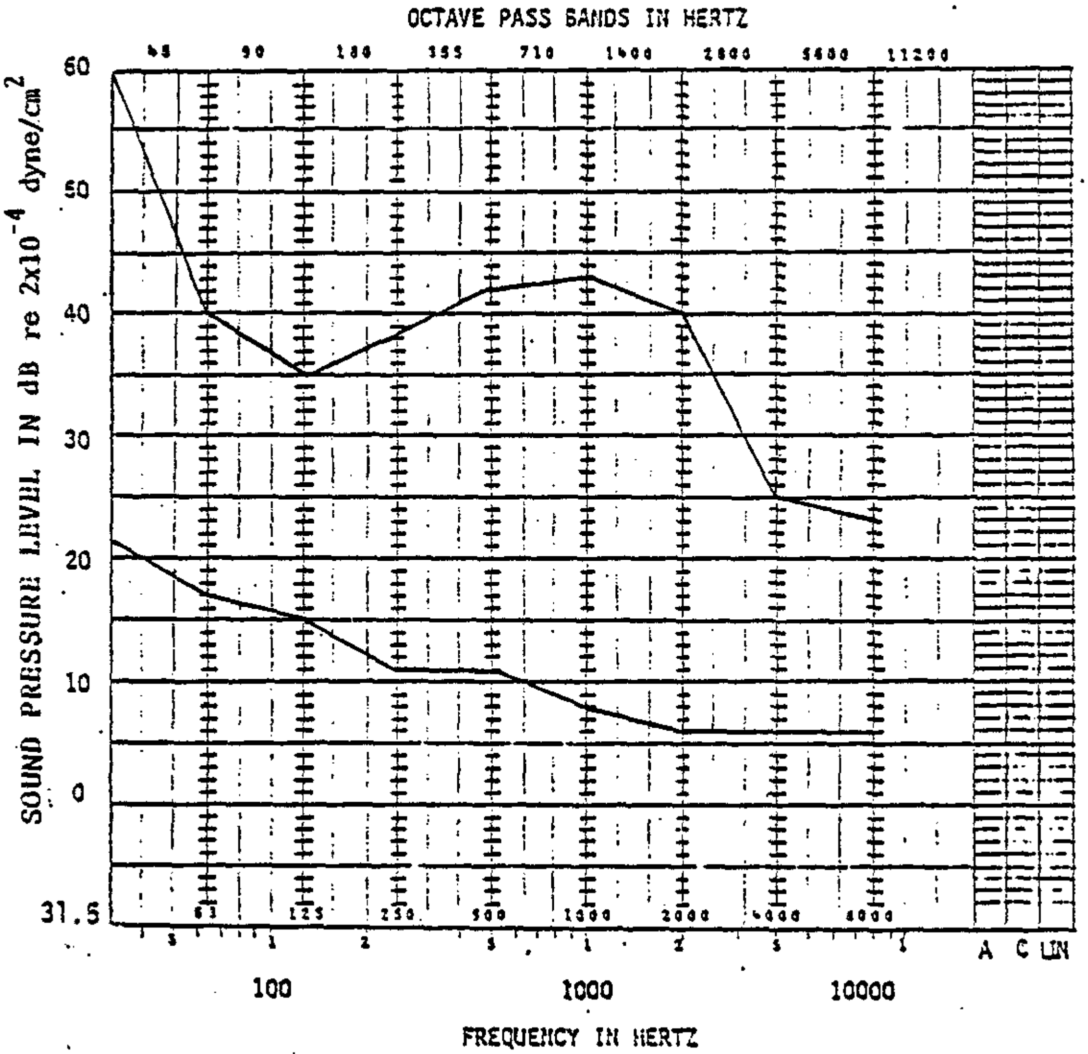
description

Figure 3.4-4: Site 4 - Fall

16 - 49 dBA

Upper Curve - Maximum Sound Pressure Levels Measured

Lower Curve - Minimum Sound Pressure Levels Measured



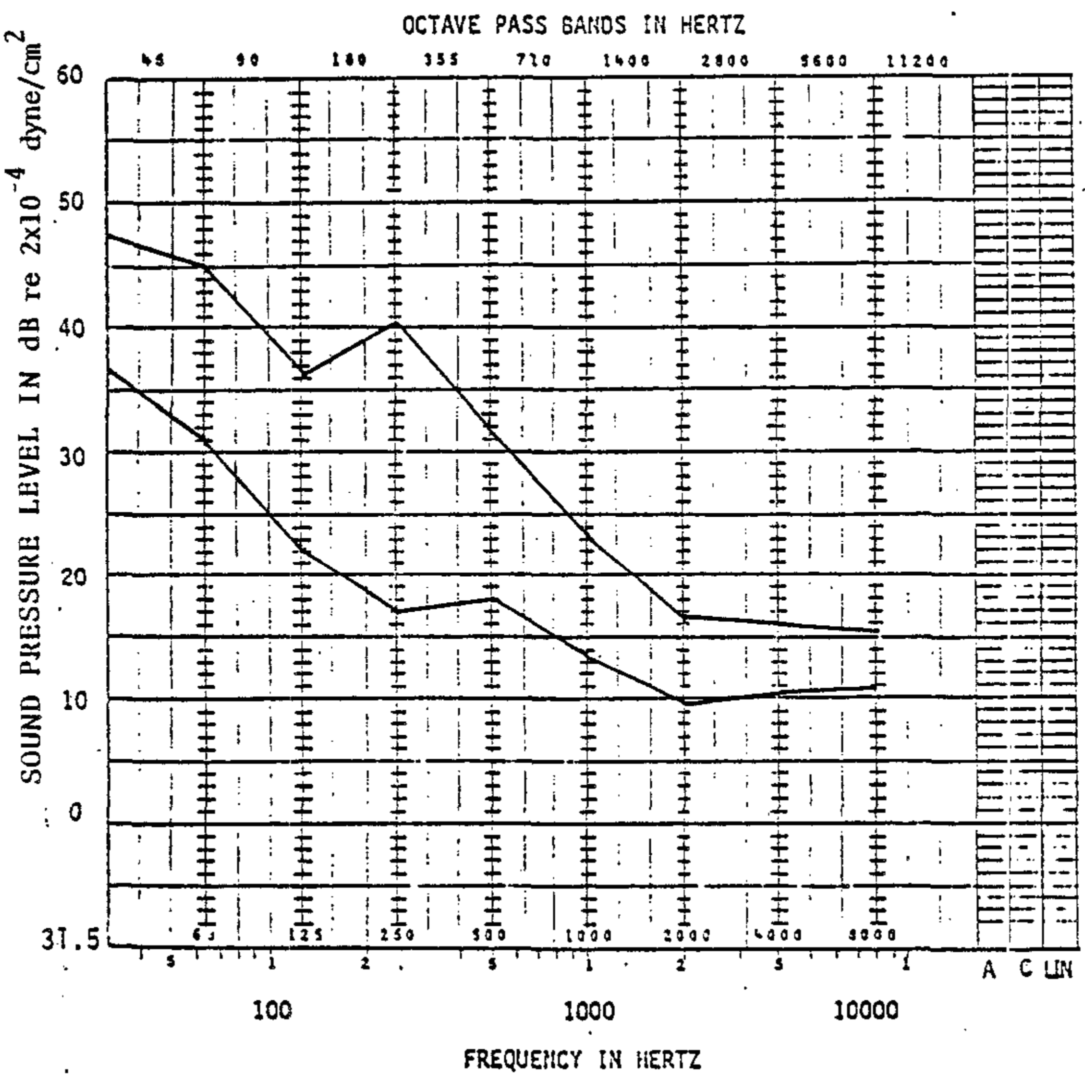
date	time	by	file	P
Feb. and March '77			72-161-2	5 OF 8

description

Figure 3.4-5: Site 1 - Winter
20.5 - 29.5 dBA

Upper Curve - Maximum Sound Pressure Levels Measured

Lower Curve - Minimum Sound Pressure Levels Measured

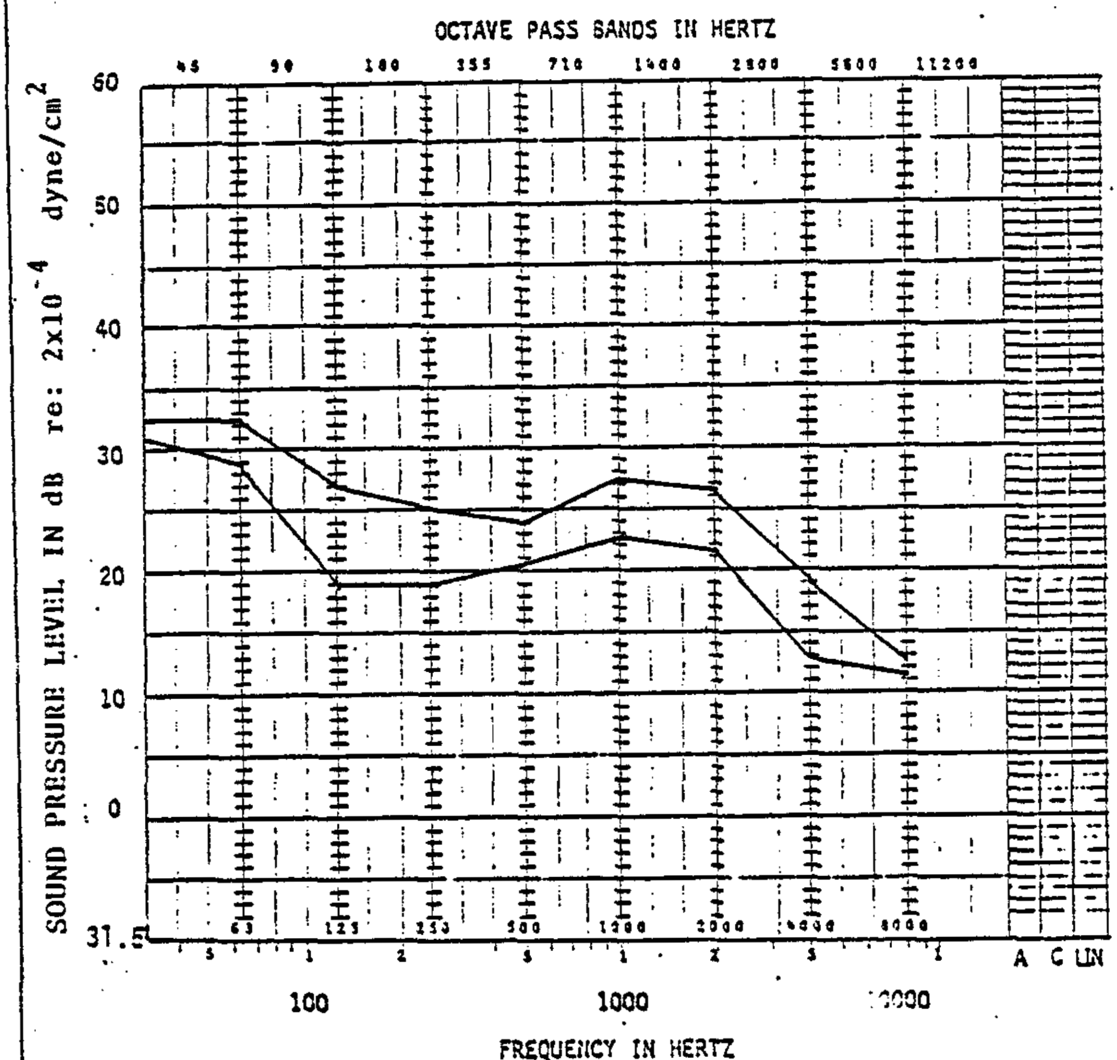


date	time	by	file	P OF
Feb. and March '77			72-161-2	6/8

description

Figure 3.4-6: Site 2 - Winter
26.5 - 32 dBA

Upper Curve - Maximum Sound Pressure Levels Measured
Lower Curve - Minimum Sound Pressure Levels Measured

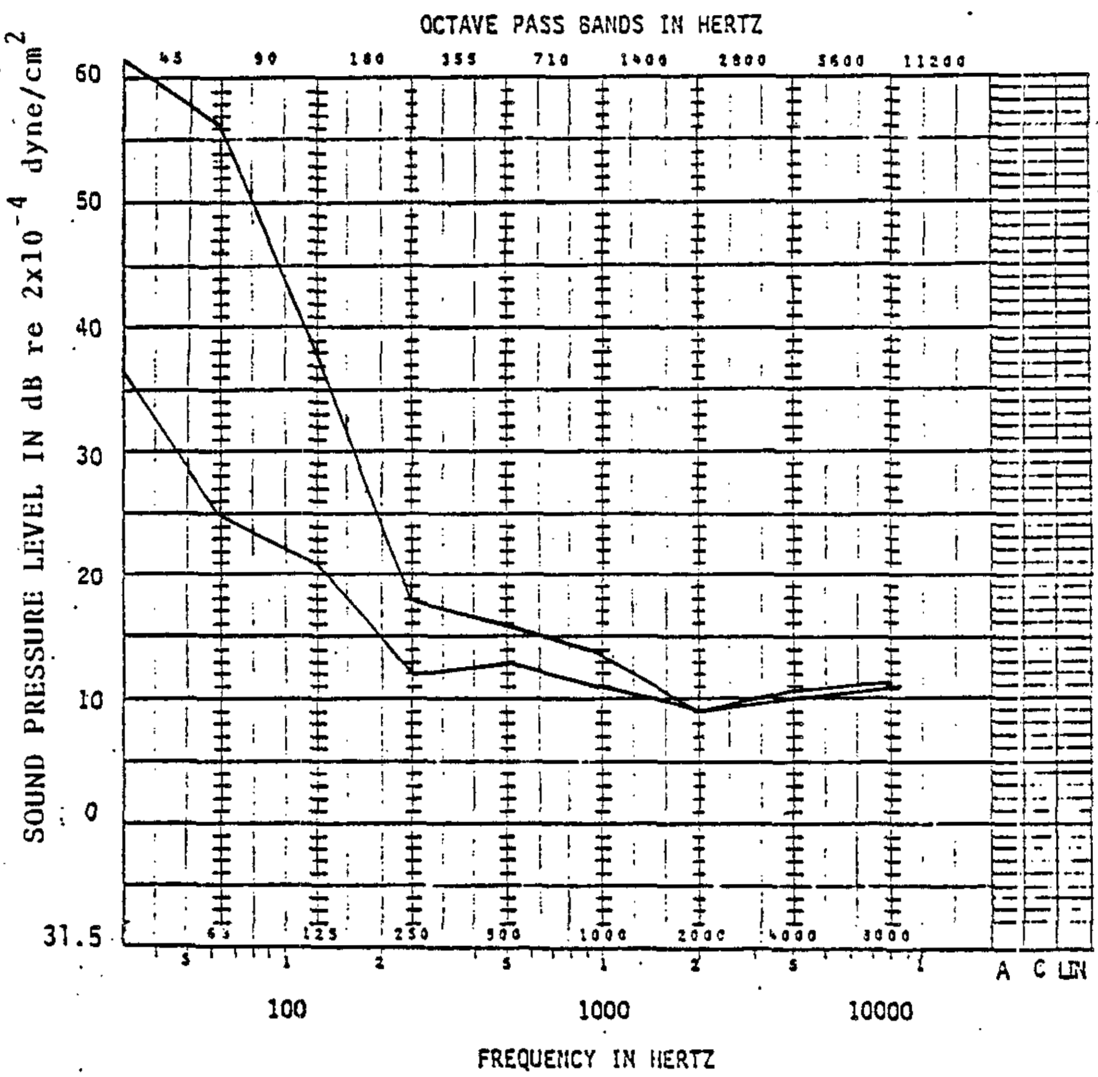


date	time	by	file	P
Feb. and March '77			72-161-2	7 OF 8

description

Figure 3.4-7: Site 3 - Winter
19-30 dBA

Upper Curve - Maximum Sound Pressure Levels Measured
Lower Curve - Minimum Sound Pressure Levels Measured



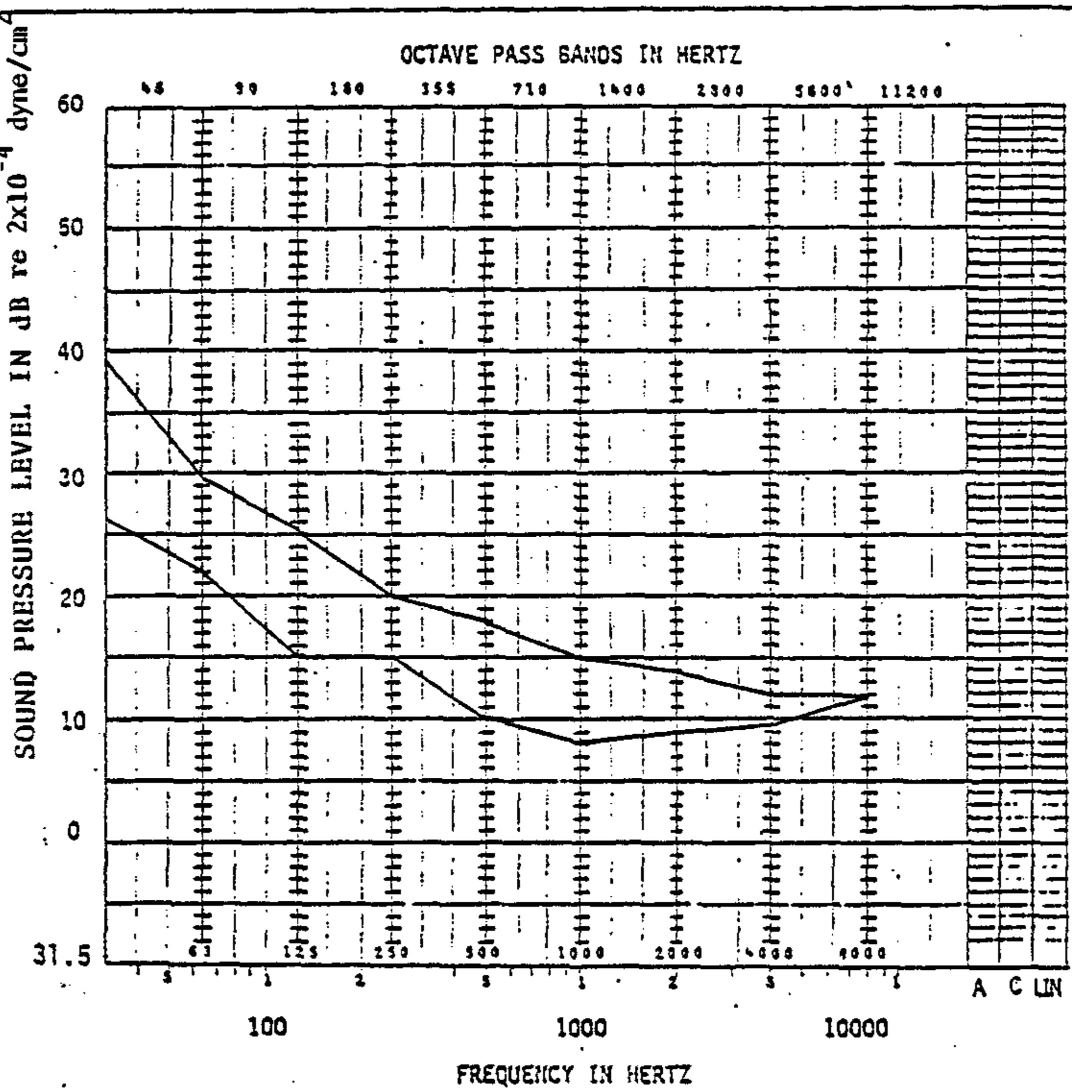
date	time	by	file	P
Feb. and March '77			72-161-2	8 OF 8

description

Figure: 3.4-8: Site 4 - Winter
18 - 20.5 dBA.

Upper Curve - Maximum Sound Pressure Levels Measured

Lower Curve - Minimum Sound Pressure Levels Measured



4.0 DISCUSSION

Upon reviewing the noise data acquired, no consistent difference is apparent between fall and winter at any of the monitoring sites. At sites 3 and 4 where the noise environments are dominated by natural sounds, there was no significant differences between weekdays and weekends. Although the reported results indicate that the measured levels were higher on weekends at sites 3 and 4, this is attributable to wind and rain which prevailed during the weekend monitoring. At sites 1 and 2, it appears that noise levels are slightly higher on weekdays than on weekends (probably due to increased truck traffic and, at site 1, to more frequent operation of the nearby cement plant.

At sites 1 and 2 (both on Highway 12), the noise environments are completely controlled by traffic noise. The day-night equivalent levels (Ldn) ranged from 44 to 51. At sites 3 and 4, natural sources such as wind, rain and wildlife control the Ldn values which ranged from 32 to 41.

ADDENDUM - FEBRUARY 23, 1978

BASELINE NOISE MONITORING NEAR SITE OF
PROPOSED PUMPING STATION, ASHCROFT, B.C.

1.0 INTRODUCTION

In May 1977, ambient noise levels were monitored in Ashcroft, B. C. in the vicinity of the proposed pumping station for the Hat Creek water supply line. The purpose of the measurement was to provide information which would assist in predicting what impact, if any, would result in the community from construction and operation of the pumping station.

2.0 DATA ACQUISITION

The equipment and procedures used on this occasion were the same as those used for the winter monitoring in the Hat Creek Valley.

2.1 Site Description

The monitoring site was designated as Site 5 to distinguish it from Sites 1, 2, 3, and 4 which were located in the Hat Creek Valley. Its location was chosen to provide data on existing noise levels indicative of the area most likely to be impacted by the proposed pumping station. The monitoring site was situated on the Circle 7 Ranch at the location indicated in Figure 2.1 of this Addendum. The microphone was located in a grassy area approximately 70 feet from an infrequently used dirt road.

The predominant noise sources at Site 5 included frequent train traffic on both the C. P. and C. N. Lines, wind noise and infrequent local traffic on the adjacent dirt road.

2.2 Monitoring Schedule and Meteorological Conditions

Noise monitoring at Site 5 was conducted from 11:00 p.m. on May 26, 1977 (a Thursday) until 10:00 p.m. on May 27, 1977 (a Friday). Throughout this period, the weather was dry

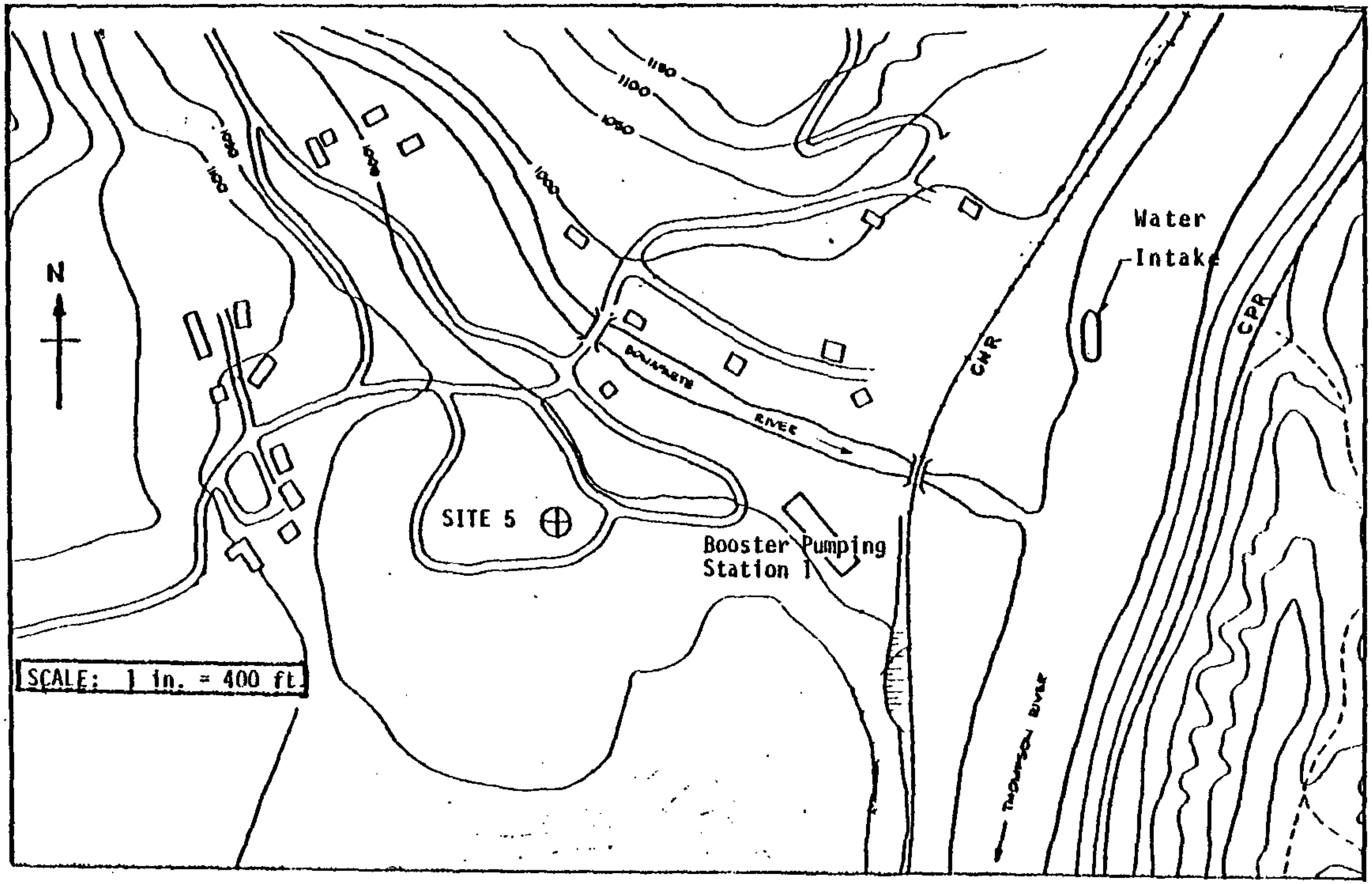


FIGURE 2-1: BASELINE NOISE MONITORING SITE 5 NEAR MAKE-UP COOLING WATER SUPPLY INTAKE AT ASHCROFT.

and sunny with a maximum temperature of 18°C and a minimum of 3°C (temperature data obtained from government weather observer). Wind speed was automatically recorded on tape whenever noise levels at the lab exceeded a preset value. When this data was taken from the tape recording it became apparent that some wind gusts exceeded 12 m.p.h. and hence the noise data obtained could contain some contribution from microphone wind noise. In order to assess the significance of any such contribution, the L_{dn} for Site 5 was predicted empirically considering the known characteristics of the nearby train traffic which was the predominant source of noise.[1] The predicted value of L_{dn} was 54.5 which agrees very closely with the value of 56 derived from the measurements. This suggests that the measured L_{dn} was determined primarily by train traffic and any contribution from microphone wind noise was small.

3.0 RESULTS

Procedures used for combining statistical indices and equivalent energy descriptors were the same as those used on the fall and winter data (i.e. Sites 1 to 4). The statistical indices computed at Site 5 are portrayed by the cumulative distributions presented in Figure 3.0 of this Addendum. Values of Ld, Ln, $Leq_{(24)}$ AND Ldn obtained at this location were 50, 49, 50 and 56 dBA respectively.

[1] The empirical model used to predict train noise was developed by Wyle Laboratories and is described in their Report WCR 73-5, July, 1973. The volume of train traffic was ascertained by communication with Canadian Pacific and Canadian National Railways.

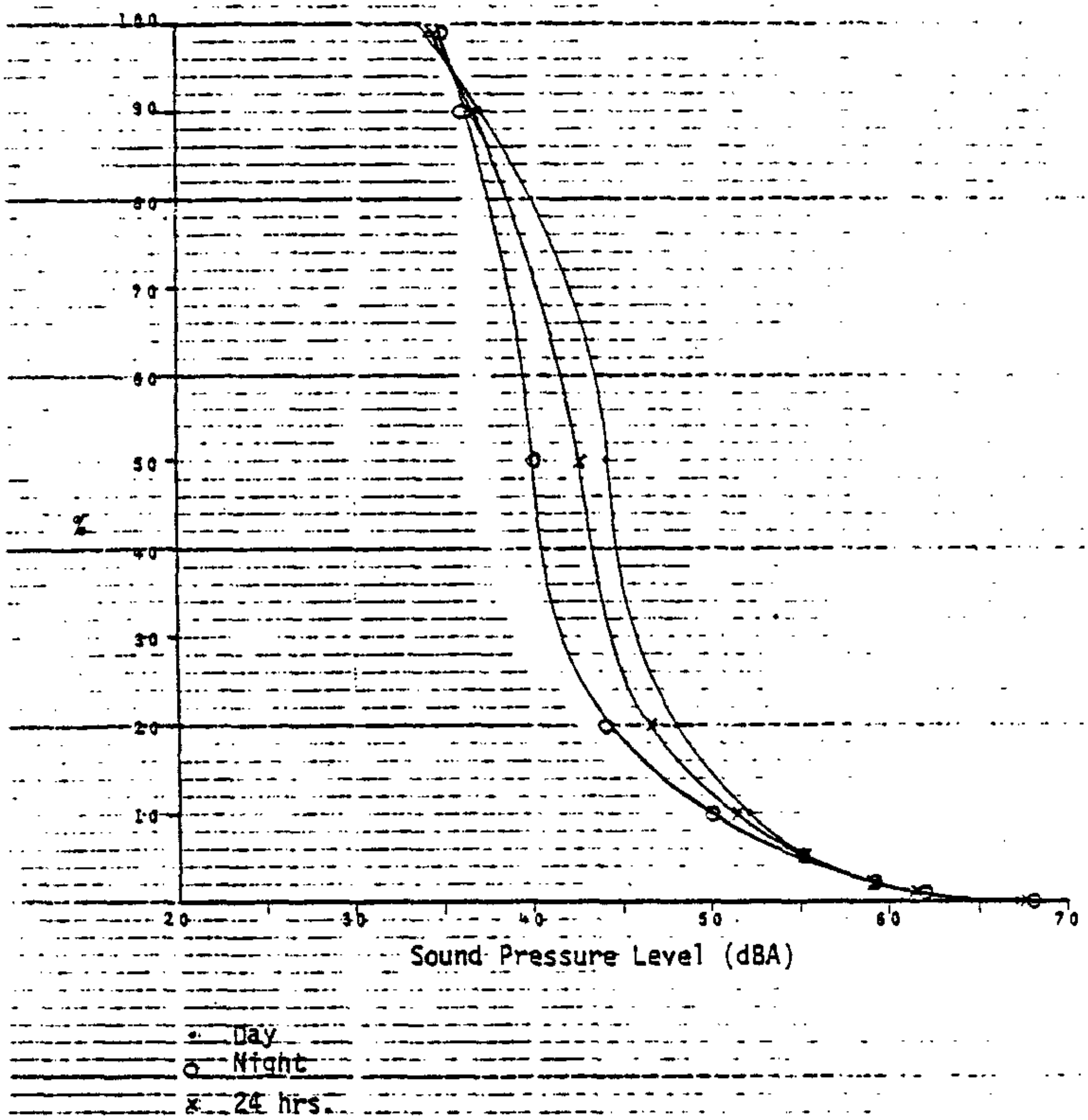


FIGURE 3.0: Site 5 - Spring, Cumulative Distributions of Excedence Levels for Day, Night and 24 Hours.

APPENDIX B

PROJECT EQUIPMENT

SOUND POWER AND SOUND PRESSURE LEVELS

UNIT YEARS	EQUIPMENT		SOURCE OF NOISE LEVEL DATA	OCTAVE BAND CENTRE FREQUENCY (Hz)									dBA
	TYPE	MAKE & MODEL		31.5	63	125	250	500	1K	2K	4K	8K	
2.7	Bulldozer	CAT D9H	Measurement; Kaiser Resources	75	79	82	76	80	76	76	76	66	82.5
4.9	Bulldozer	CAT D8K	Measurement; Bulk Sample Prog.	85	90	83	83	80	78	75	67	59	83
6.1	Bulldozer	CAT D7	Measurement; Bulk Sample Prog.	83	88	85	83	80	81	81	75	64	83
8.1	Grader	Wabco 660B	Measurement; Bulk Sample Prog.	82	85	80	83	86	81	79	75	70	87
13.9	Off-Road Truck	DJB CAT (D250 Engine)	Measurement; Bulk Sample Prog.	80	84	84	74	75	76	77	65	59	81
16.9	Front-end Loader	CAT 966C	Measurement; Bulk Sample Prog.	86	81	89	78	79	74	71	65	66	81
18.2	Scraper	CAT 637D[1]	Measurement; Kaiser Resources	82	86.5	90	92.5	87.5	86	83	79	75.5	89.5
4.0	Dump Truck	Mack DM-600[2]	Drive-By Measurement in Lit.	79	82	86	88	75	81	67	62	62	85
2.2	Compactor	CAT 825 or 835	See Ref. 3	85	90	83	83	80	78	75	67	59	83
5.9	Backhoe	CAT 225 or 235	See Ref. 4	86	91	89	78	79	74	71	65	66	81
0.6	Truck Crane	Grove TM 650, 800	Finning Tractor	79	82	86	88	86	75	71	67	62	85

TABLE B-1: SOUND PRESSURE LEVELS (re. 20 μPa) AT 15 m (50 ft.) FROM PLANT CONSTRUCTION EQUIPMENT UNDER LOAD (NUMBERS OF UNIT-YEARS ARE FOR 1978-79).

UNIT - YEARS	EQUIPMENT		SOURCE OF	OCTAVE BAND CENTRE FREQUENCY (Hz)									dBA
	TYPE	MAKE & MODEL	NOISE LEVEL DATA	31.5	63	125	250	500	1K	2K	4K	8K	
3.3 (1983)	Crawler Crane	Manitowoc 3900 W, 4000 W	See Ref. 5	69	73	79	77.5	79.5	76.5	72	66	57.5	81
1.3 (1982)	Stiff-Leg Derrick	Manitowoc 4100 W	See Ref. 5	69	73	79	77.5	79.5	76.5	72	66	57.5	81
1.2	Cherrypicker	Clark 714 or 720	See Ref. 6	69	73	79	77.5	79.5	76.5	72	66	57.5	81
7.0 (1980)	Concrete Truck	Mack DM-600	Use Cummins NTO-262 Data	79	82	86	88	86	75	71	67	62	85

REFERENCES:

1 Used CAT 657B data less 2 dB to correct for horsepower difference.

2 Used data from drive by of Commins NTO-262, a unit with similar power. Ref.: Lyon, Lectures in Transportation Noise, p. 139.

3 For compactors, CAT 825 or 835 used CAT D8K bulldozer data; similar horsepower and weight.

4. For CAT 225 or 235 backhoe, used CAT 966C loader data; similar horsepower and engine speed.

5. Estimated noise of crane on basis of its engine: GM 12v71-N. Engine noise previously measured.

6 Supplier (Williams Machinery) stated Clark cherrypickers meet California noise code of 85 dBA at 50 ft. Therefore used crawler crane data.

TABLE B-1 (CONTINUED)

UNIT - YEARS	EQUIPMENT		SOURCE OF	OCTAVE BAND CENTRE FREQUENCY (Hz)									dBA
	TYPE	MAKE & MODEL	NOISE LEVEL DATA	31.5	63	125	250	500	1K	2K	4K	8K	
4	Rock Drill	Gardner Denver 3100A (4")	Atlas Copco ROC 601 (5")	85	89	91	92	94	96	96	94	91	98
4	Compressor	Engersoll-Rand DXL-900	EPA, Noise Emission Standards for Construction Equipment	67	72	76	73	80	77	70	63	53	81
30.3	Off-Road Trucks	Wabco 150B	Manufacturer	77	83	87	90	87	87	81	76	64	91
9	Bulldozer	CAT D9H	Measurement: Kaiser Resources	75	79	82	76	80	76	76	74	66	82.5
2	Wheeldozer	CAT 824	Bulk Sample Prog Use 621B Scraper Data	78	85	82	83	80	76	73	66	60	82
9	Grader	CAT 16G	Use CAT 621B Scraper Data	78	85	82	83	80	76	73	66	60	82
7	Scraper	CAT 666B	Use CAT 657B Data from Kaiser Resources	84	88.5	92	94.5	89.5	88	85	81	77.5	91.5
3	Compactors	CAT 825B	Use CAT 621B Scraper Data	78	85	82	83	80	76	73	66	60	82

TABLE B-2 SOUND PRESSURE LEVELS (re. 20 μPa) AT 15 m (50 ft.) FROM MOBILE MINING EQUIPMENT UNDER LOAD. (NUMBERS OF UNIT-YEARS REFER TO MINE STAGE 6, PIT SUPERFICIALS).

UNIT-YEARS	EQUIPMENT TYPE	EQUIPMENT MAKE & MODEL	SOURCE OF NOISE LEVEL DATA	31.5	63	125	250	500	1K	2K	4K	8K	dBA
				OCTAVE BAND CENTRE FREQUENCY (Hz)									
12.8	Bulldozer + Compactor	CAT D8K CAT 825	Measurement of D8K Bulk Sample Prog.	85	90	83	83	80	78	75	67	59	83
7.9	Rock Drill	Atlas Copco ROC 601		85	89	91	92	94	96	96	94	91	98
7.9	Compressor	Ingersoll-Rand DXL-900	EPA	67	72	76	73	80	77	70	63	53	81
1.4	Front-end Loader	CAT 966C	Measurement: Bulk Sample Prog.	86	91	89	78	79	74	71	65	66	81
3.0	Grader	Wabco 660B	Measurement, Bulk Sample Prog.	82	85	80	83	86	81	79	75	70	87
5.25	Off-road Truck	Wabco 150B	Manufacturer	77	83	87	90	87	87	81	76	64	91
17.5	Various Service Trucks	Cummins NTO-262	Drive-by Measurement in Literature	79	82	86	88	86	75	71	67	62	85
0.3	Crushing Plant	Pioneer, 200 ton/hr.		74	76	77	70	70	71	73	71	69	78
3.5	Highway Dump Trucks	Cummins NTO-262	Drive-by Measurement in Literature	79	82	86	88	86	75	71	67	62	85
9.7	Scraper	CAT 637D	Measurements: Kaiser Resources	82	86.5	90	92.5	87.5	86	83	79	75.5	89.5

TABLE B-3: SOUND PRESSURE LEVELS OF ACCESS ROAD CONSTRUCTION EQUIPMENT (EXCAVATION AND BASE COURSE) UNDER LOAD. (re 20 μPa) AT 15 m (50 ft.) (UNIT YEARS RELATE TO THE EXPECTED 14-MONTH DURATION OF THIS CONSTRUCTION)

UNIT-YEARS	EQUIPMENT TYPE	EQUIPMENT MAKE & MODEL	SOURCE OF NOISE LEVEL DATA	OCTAVE BAND CENTRE FREQUENCY (Hz) 31.5	63	125	250	500	1K	2K	4K	8K	dBA
0.83	Tug Boat	Westminster Shaman (43 ft.)	Measurement (Bollard-Pull)	73	78	89	88	80	77	76	65	62	84
0.83	Clamshell Crane	Crawler Crane Data; Manitowac 3900 W	Measurement, GM 12v71-N Engine	69	73	79	77.5	79.5	76.5	72	66	57.5	81
0.83	Pile Driver	Unknown	EPA Peak dBA data Spectrum Estimated (L_{eq} 90)*	83	86	90	93	95	95	95	91	86	101
1.66	Compressor	Ingersoll-Rand DXL 900	EPA	67	72	76	73	80	77	70	63	53	81
3.32	Dump Truck	Use Cummins NTO-262 data	Drive-by Test in Literature	79	82	86	88	86	75	71	67	62	85
1.66	Mixer Truck	Use Cummins NTO-262 data	Drive-By Test in Literature	79	82	86	88	86	75	71	67	62	85
0.83	Loader	CAT 966C	Measurement, Bulk Sample Prog.	86	91	89	78	79	74	71	65	66	81

*EPA gives L_{eq} 85 for pile driver at non-residential construction sites. Have assumed L_{eq} 90 for water-intake construction to be conservative.

TABLE B-4: MAKE-UP COOLING WATER SUPPLY - INTAKE CONSTRUCTION EQUIPMENT SOUND PRESSURE LEVELS (re 20 μPa) AT 15 m (50 ft.) UNDER LOAD. (UNIT-YEARS RELATE TO THE EXPECTED 10-MONTH DURATION OF CONSTRUCTION.)

UNIT YEARS	EQUIPMENT TYPE	MAKE & MODEL	SOURCE OF NOISE LEVEL DATA	OCTAVE BAND CENTRE FREQUENCY (Hz) 31.5	63	125	250	500	1K	2K	4K	8K	dBA
2	Crane	Assume Manitowoc 3900W	Measurement, GM 12V71-N Engine	69	73	79	77.5	79.5	76.5	72	66	57.5	81
2	Backhoe	CAT 225	Use measured data for CAT 966C Loader	86	91	89	78	79	74	71	65	66	81
3	Bulldozer	CAT D7	Measurement, Bulk Sample Program	83	88	85	83	80	81	81	75	64	83
2	Front-end Loader	CAT 966C	Measurement, Bulk Sample Program	86	91	89	78	79	74	71	65	66	81
2	Mixer Truck	Use Cummins NTO-262 Data	Drive-By Measurement from Literature	79	82	86	88	86	75	71	67	62	85
2	Compressor	Ingersoll-Rand DXL- 900	EPA	67	72	76	73	80	77	70	63	53	81

TABLE 8-4A: MAKE-UP COOLING WATER BOOSTER PUMPING STATION CONSTRUCTION EQUIPMENT SOUND PRESSURE LEVELS (re 20 μPa) AT 15 m (50 ft.) UNDER LOAD

NO. UNITS	EQUIPMENT		SOURCE OF NOISE LEVEL DATA	OCTAVE BAND CENTRE FREQUENCY (Hz)									dBA
	TYPE	MAKE & MODEL		31.5	63	125	250	500	1K	2K	4K	8K	
8	Bulldozer with Ripper	CAT D7	Measurement, Bulk Sample Prog.	83	88	85	83	80	81	81	75	64	83
8	Backhoe	CAT 225	Use Measured data for CAT 966C Loader	86	91	89	78	79	74	71	65	66	81
16	Side-boom Tractors	CAT 572G	Use CAT D9H Dozer data, similar power	75	79	82	76	80	76	76	74	66	82.5
4	Crawler Crane	Manitowoc 3900W	Measurement of GM 12V71-N Engine	69	73	79	77.5	79.5	76.5	72	66	57.5	81
2	Graders	Wabco 660B	Measurement, Bulk Sample Prog.	82	85	80	83	86	81	79	75	70	87
6	Compressor	Ingersoll-Rand DXL-900	EPA	67	72	76	73	80	77	70	63	53	81
3	Front-end Loader	CAT 966C	Measurement, Bulk Sample Prog.	86	91	89	78	79	74	71	65	66	81
6	Dump Truck	Use Cummins NTO-262 data	Drive-by Measurement in Literature	79	82	86	88	86	75	71	67	62	85

TABLE 8-5: MAKE-UP COOLING WATER PIPELINE CONSTRUCTION EQUIPMENT SOUND PRESSURE LEVELS (re 20 μPa) AT 15 m (50 ft.) UNDER LOAD.

NOISE SOURCE	COMMENTS		OCTAVE BAND CENTRE FREQUENCY (Hz)								dBA
			31.5	63	125	250	500	1K	2K	4K	
Turbine Hall and Boiler House	Surface Radiation (Worst case directivity)		123	112	100.5	89.5	78.5	70	65.5	61	91
Forced Draft and Primary Air Fans	From Intake Louvres	Worst-Case Fans	111	104	103	111	97	92	81	75	104
		Best-Case Fans	80	73	68	72	84	77	69	55	83
Induced Draft Fans	From top of Stack	Worst-Case Fans	99.5	86.5	82	92.5	81.5	75.5	66.5	53.5	86
		Best-Case Fans	65.5	50	44	53.5	66.5	60.5	52.5	38.5	65.5
Transformers	Based on Measurements of Centralia, Washington		83	89	93.5	83	84.5	80	72	61	85
Natural Draft Hyperbolic Cooling Towers (2)	At Base of Towers		46*	52*	58*	64	70	74	76	76	82
Mechanical Draft Cooling Towers (4)	Included for Comparison only. Source: Measurement of Centralia, Washington		87	86	81	80	80	79	75	73	83
Airblast Circuit Breakers (Pressurized Head)	Peak Linear SPL's of Worst-case breakers (Reference 46)		147	160	145	135	135	135	136	137	160 dB Lin.

* This data was obtained by extrapolation of spectrum shape.

TABLE B-6: SOUND PRESSURE LEVELS AT 15 m (50 ft.) FROM EFFECTIVE ACOUSTIC CENTRES OF SIGNIFICANT POWER PLANT NOISE SOURCES (TOTAL OF FOUR GENERATING UNITS).

NOISE SOURCE	COMMENTS	OCTAVE BAND CENTRE FREQUENCY (Hz)									dBA
		31.5	63	125	250	500	1K	2K	4K	8K	
Stacker and Reclaimer (2 units)	Data from Measurements of Stephens-Adamson 4000 ton/hour unit at Roberts Bank	84	84	80.5	80	82.5	75.5	73	64	65	82
Primary and Secondary Crusher House	Assuming Average Interior SPL of 95 dBA and Insulated metal sandwich panel walls.	71	70	67	63	51	46	40	31	21	58
Mobile Clean-up Equipment at Coal Stockpiles	Total SPL's from: 1- CAT D8K Dozer 2- CAT 966C Loaders Without coal pile shielding and with 75% Usage Factors	89.5	94.5	91.5	84	83	79.5	76.5	69.5	68	85

TABLE B-7: SOUND PRESSURE LEVELS (re. 20μ Pa) AT 15m (50 ft.) FROM EFFECTIVE ACOUSTIC CENTRES OF COAL PREPARATION FACILITY EQUIPMENT

OCTAVE BAND CENTRE FREQUENCY (Hz)

	31.5	63	125	250	500	1K	2K	4K
Integ-Ebasco Base Wall Section	5*	11*	17*	23*	29*	35*	38*	42*
Alternate 1: Forma-Wall[A] (Riverbank Test: TL 70-200	7*	13*	19	25	25	24	45	48
Alternate 2: Nu-Line Panels[B] (Riverbank Test: TL 64-316)	7*	13*	19	26	47	55	59	60
Perforated Inner Sheet Design[C]	6*	10*	15	20	27	35	38	43

*: These values were estimated from Field-Incidence Mass Law Theory

A: Construction - 22 gauge steel/1 7/8 in. polyurethane foam insulation/ 22 gauge steel

B: Construction - 18 gauge steel (exterior sheet)/1.5 in., 2.5 lb. density rockwood insulation/16 gauge corrugated aluminum

C: Construction - 21 gauge aluminum (exterior)/1.5 in. glass fibre board/ 18 gauge galvanized, perforated steel.

TABLE B-8: SOUND TRANSMISSION LOSS VALUES (dB) FOR BASE BOILER HOUSE AND TURBINE HALL WALL DESIGN AND ALTERNATES

Babcock & Wilcox Canada Ltd.

AXIAL FLOW FAN SP_WL SUMMARY

B.C. HYDRO, HAT CREEK

Frequency (Hz)	Sound Power Level - dB (ref. 10^{-12} Watts)								
	31.5	63	125	250	500	1000	2000	4000	8000
F.D. Fan: 760,000 ACFM; 24.5 in.W.G.; 105°F; 3500 H.P.									
Novenko (1190 rpm): at inlet	106	99	99	110	127	123	118	107	97
through casing	97	93	91	96	108	101	93	79	66
Westinghouse (1185 rpm) (re. 10^{-13} W)	-	145	148	162	154	150	144	138	135
Howden Parsons (870 rpm)	-	122	122	129	138	137	134	128	121
TLT-Babcock (1180 rpm)	139	132	134	138	135	132	127	118	108
Sheldons (885 rpm)	-	108	120	128	135	131	128	122	114
I.D. Fan: 1,435,000 ACFM; 27.2 in.W.G.; 270°F; 6500 H.P.									
Novenko (890 rpm): at inlet	107	101	101	113	129	125	120	109	99
through casing	99	95	93	98	110	103	95	81	68
Westinghouse (885 rpm) (re. 10^{-13} W)	-	148	151	165	157	153	147	141	138
Howden Parsons (870 rpm)	-	125	125	132	141	140	137	131	125
TLT-Babcock (700 rpm)	141	141	142	140	136	134	128	119	109
Sheldons	- Fan Design Not Available -								
P.A. Fan: 487,200 ACFM; 60 in.W.G.; 105°F; 4500 H.P.									
Novenko (1190 rpm): at inlet	112	107	105	115	133	129	124	113	103
through casing	103	99	97	102	114	107	99	85	72
Westinghouse (1785 rpm) (re. 10^{-13} W)	-	150	153	167	159	155	149	143	140
Howden Parsons	- Fan Design Not Available -								
TLT-Babcock (1180 rpm)	144	141	143	147	145	142	138	129	119
Sheldons	- Fan Design Not Available -								

APPENDIX C

SAMPLE CALCULATIONS

APPENDIX C

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APPENDIX C

C1.0 SAMPLE CALCULATIONS

C1.1 INTRODUCTION

This appendix contains brief demonstrations of all mathematical (emptrical and theoretical) models that have been used to generate sound power level data for project components. In addition, a description is given of how mine's distributed sound source region was approximated.

C1.2 CONTINUOUS NOISE SOURCES

(a) Boiler House and Turbine Hall Noise Radiation

Problem: Estimate Total sound power level to be radiated from the completed boiler house (B.H.) and Turbine Hall (T.H.)

Solution:

Step 1: Calculate total exterior surface area (A) of B.H. and T.H. in m^2; A=89,500 m^2 (957,500 $ft.^2$)

Step 2: Estimate Interior sound pressure level (SPL) in B.H. and T.H. Assume that a reverberant sound pressure level of 95 dBA is attained throughout. Adopt a noise spectrum to produce 95 dBA in which each octave band from 31.5 to 8000 Hz makes an equal contribution to the overall A-weighted noise level. (Reference C[1]); see line 1 of Worksheet 1.

HAT CREEK PROJECT: SAMPLE CALCULATION WORKSHEET

LINE	CALCULATION DESCRIPTION	OCTAVE BAND CENTRE FREQUENCY (Hz) 31.5	63	125	250	500	1000	2000	4000	8000
1	SPL at interior surfaces (dB re. 20 μPa)	111	106	100.5	95.5	90.5	88	86.5	86	87
2	Transmission loss of Building Skin (dB)	5	11	17	23	29	35	38	42	46
3	SPL at exterior surface of building skin = line 1 - line 2	106	95	83.5	72.5	61.5	53	48.5	44	41
4	SWL ≈ SPL + 10 $\log_{10}$ A = Line 3 + 49.5 dB (dB re 10^{-12} W)	155.5	144.5	133	122	111	102.5	98	93.5	90.5

Worksheet No. 1; Title: Boiler House and Turbine Hall Surface-Radiated Sound Power

Harford, Kennedy, Wakefield Ltd

Step 3: Estimate transmission loss of B.H. and T.H. exterior surfaces, these to be the "base" design: 22 gauge outer steel sheet/3.8 cm (1.5 in.) fibreglass board of 26.4 kg/m³ (1.65 lb./ft.³) density/24 gauge inner steel sheet. Transmission loss values were estimated using random incidence mass law theory[C9]; see Line 2 of worksheet.

Step 4: Subtract Line 2 from line 1 to give the sound pressure level at the exterior of the B.H. and T.H., then make standard approximation that SPL equals sound intensity level (SIL) for free, progressive sound waves.

Step 5: Calculate total sound power level (SWL) from the SIL at the exterior surface and the total surface area:

$$SWL = SIL + 10 \log_{10} A \quad dB \qquad \text{C-1}$$

$$\approx SPL + 49.5 \text{ dB}$$

Step 6: Account for directivity of B.H. and T.H. sound source. Building is 3 times as long as is wide, therefore, will radiate more noise from sides than from ends. The directivity has been handled conservatively by assuming the radiation in all directions as that of a side.

(b) Fan Noise

Problem: To check the sound power level data provided by various potential suppliers of the major plant fans (forced air, induced craft and primary air fans) against an empirical model developed by an impartial source.

Solution:

Step 1: Select a fan noise model developed at the Buffalo Forge Company (not a potential supplier) which utilizes fan delivery volume Q (cfm) and static pressure P (inches of water) as its main parameters. See Reference C2.

Step 2: As an example, consider the induced draft fans (two per unit) for which the test block conditions are $Q = 1.435 \times 10^6$ cfm and $P = 27.2$ in. of water. The fans are expected to be of the vaneaxial type.

Step 3: Calculate the sound power level (SWL) of a single fan as follows:

$$SWL = K_\omega + 10 \log_{10} Q + 20 \log_{10} P \quad db \qquad \text{C-2}$$

$$= K_\omega + 10 \log_{10} (1.435 \times 10^6) + 20 \log_{10} (27.2)$$

$$+ 20 \log_{10} (27.2) \text{ dB}$$

$$= K_\omega + 90 \text{ dB.}$$

Where K_ω is the specific SWL of the particular fan type, here vaneaxial. The values of K_ω for vaneaxial fans are given in Line 1 of Worksheet 2.

HAT CREEK PROJECT: SAMPLE CALCULATION WORKSHEET

LINE	CALCULATION DESCRIPTION	OCTAVE BAND CENTRE FREQUENCY (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
1	Specific SWL of Vanexial Fan, K_ω	48	42	39	41	42	40	37	35	25
2	SWL = $K_\omega + 10 \log_{10} Q + 20 \log_{10} P = K_\omega + 90$ dB	138	132	129	131	132	130	127	125	115
3	Blade Frequency Increment				7					
4	Total Calculated SWL of Induced Draft Fan	138	132	129	138	132	130	127	125	115
5	Maximum Manufacturer's SWL	144	141	142	155	147	143	137	131	128
6	Minimum Manufacturer's SWL	110	104	104	116	132	128	123	112	102

Worksheet No. 2: Calculation of Induced Draft Fan Sound Power Levels.

Step 4: Apply "blade frequency increment" in the octave band in which the blade-passing frequency falls. The blade-passing frequency of the various manufacturer's fans fall in either the 250 or 500 Hz bands, here the former is assumed. For vaneaxial fans, the blade frequency increment is 6 to 8 dB, 7 dB is assumed here. See Line 3.

Step 5: Add lines 2 and 3 to get total SWL's for induced draft fan (line 4.).

Step 6: Compare calculated SWL's with manufacturer's data. Lines 5 and 6 are the maximum and minimum values, in each octave band, of the data supplied by four manufacturers. It is seen that the calculated SWL's are well within the range of manufacturer's data except at 500 Hz. The selection of a 500 Hz blade-passing frequency would correct this situation.

This model was also used to calculate the noise levels from the four centrifugal fresh air fans to be located on the west side of the turbine hall. These levels were shown to be insignificant compared to other noise sources.

(c) Cooling Tower Noise Radiation

Problem: Estimate the total noise level created by two 116.5 m (382 ft.) hyperbolic (natural draft) cooling towers each with a circulating water flow of 20,200 litre/sec. (320,000 U.S. gpm).

Solution:

Step 1: Selection of a recently developed empirical model for the A-weighted noise emitted by natural draft cooling towers in the 6,300 to 44,200 litre/sec. (.10 to 7.0 x 10^5 gpm) flow rate range. (Reference C3)

Step 2: Compute A-weighted cooling tower sound pressure level at distance d= 15 m (50 ft.) as follows:

$$SPL\ (d) = 64.5 + 10 \log_{10} M - 20 \log d + 10 \log \left(\frac{\tan^{-1} \alpha}{\alpha^2} \right) \pm 2\ \text{dBA.} \qquad C-3$$

Where M = water flow rate in gpm.

$\alpha = \left(1 + \frac{2R}{a}\right)^{1/2}$

R = Cooling tower basin radius in feet

Based on an analysis of nine large cooling towers, a strong correlation has been demonstrated between water flow rate and basin radius and this relationship can be expressed as:

$$R = 120 \log_{10} M - 500 \text{ ft.} \qquad \text{C - 4}$$
$$= 120 \log_{10}(320{,}000) - 500 \text{ ft.}$$
$$= 160 \text{ ft.}$$

Therefore, $\alpha = (1 + \frac{320}{50})^{\frac{1}{2}}$

$= 2.72$

and $\tan^{-1} \alpha = 1.218$ radians.

Therefore, from Equation C-2:

$$SPL(50) = 64.5 + 10 \text{ Log}_{10} (320{,}000) - 20 \text{ Log}_{10} (50)$$
$$+ 10 \text{ Log} (\frac{1.218}{7.4}) \pm 2 \text{ dBA}$$
$$= 77.5 \pm 2 \text{ dBA}$$

To be conservative, assume 79 dBA, so that total noise level at 50 ft. from two towers is 82 dBA.

Step 3: Estimate spectrum shape for cooling tower noise. Based on average shape of several natural draft cooling tower octave band sound spectra reported in Reference C[3], a spectrum was devised that would give 82.5 dBA:

	OCTAVE BAND CENTRE FREQUENCY								
	31.5	63	125	250	500	1K	2K	4K	8K
Two cooling Towers: SPL at 50 ft. (dB re 20 μPa)	46	52	58	64	70	74	76	76	75

(d) Transformer Noise

The noise levels for the main 200 MVA 500 kV transformers at the plant were obtained through measurement of those produced by the 243 MVA, 500 kV units at Centralia, Washington. However, the noise levels of transformers in the 69 kV system were obtained from B.C. Hydro. B.C. Hydro generally requires that the noise levels of transformers be 6 to 7 dBA lower than the standard level specified for them by the National Electrical Manufacturers Association (NEMA). These lower levels have been used herein.

Step 1: Select Rattlesnake Substation transformers; two 230 kV/69kV units with probable maximum capacity of 150 MVA. B.C. Hydro noise rating is 78 dBA for each unit.

Step 2: Apply noise propagation formula that allows NEMA (or B.C. Hydro) near field noise levels to be translated into noise levels in the surrounding community. The formula was developed at General Electric (Reference C4) and is:

$$\text{Distance Attenuation} = 4.4 + 20 \log_{10} \frac{d}{(wh)^{1/2}} \text{ dB} \qquad \text{C-5}$$

Where D is distance from transformer (ft.) and the product wh is the projected area of transformer (ft^2). Here a conservative value for wh is 500 ft^2.

Since the dominant tonal components of transformer noise are at low frequencies (120 and 240 Hz) for which atmospheric absorption of sound is small, this form of attenuation has been neglected.

The nearest residences are about 3,200 ft. from the two possible Rattlesnake Substation sites; the distance attenuation is then:

$$\text{Attn} = 4.4 + 20 \log_{10} \frac{3200}{(500)^{1/2}} \text{ dB}$$

$$= 47 \text{ dB}$$

The transformer noise (two units) at the nearest residents will therefore be:

$$\text{SPL (3200 ft.)} = 78 + 3 - 47 \text{ dBA}$$

$$= 34 \text{ dBA}$$

(e) Prediction of L_{dn} contours at Proposed Airstrip

Noise levels resulting from operation of the proposed airstrip have been predicted based on the following assumptions:

1. During the initial years of the project, there will be 4 landings and 4 takeoffs per day.
2. Although one of the four daily visits assumed will be B.C. Hydro aircraft (a twin turboprop), it has been generally assumed in the calculations that a Cessna 150 is typical (with respect to airspeed and climb rate) of the aircraft that will visit the strip. The B.C. Hydro plane will produce higher noise levels but it gains altitude much faster than the Cessna with the net result that its overall noise impact is about the same as for the smaller aircraft.
3. The direction of takeoffs and landings assumed at each alternative site was established by the direction of the prevailing wind.

4. A 3° glide slope was assumed for landings.

5. The proposed airstrip will only be used during the daytime hours.

The relationship between the effective perceived noise level (EPNL) and slant perpendicular distance (as defined by Figure C1-1) for an assortment of light aircraft was obtained from Appendix A, Working Paper 11 in Reference C5. The EPNL values were then converted to L_{dn} using empirically-derived formulas presented in Appendix A, Working Paper 2 in Reference C5. Having established the relationship between L_{dn} and slant perpendicular distance, it was then possible to draw L_{dn} contours based on the slant perpendicular distances which resulted from a known airspeed, rate of climb and approach glide angle.

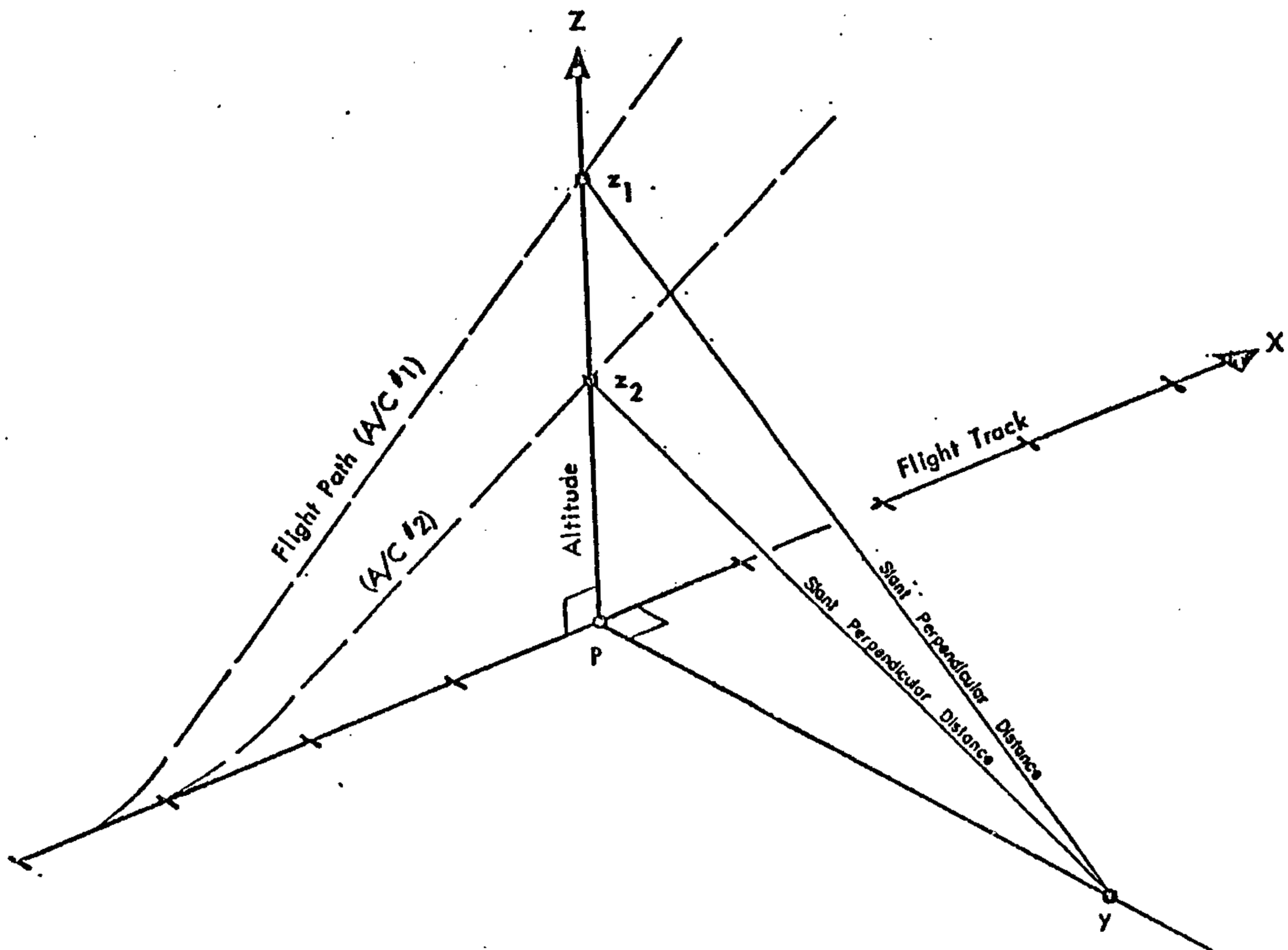

FIGURE C1-1: SLANT PERPENDICULAR DISTANCE

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C1.3 INTERMITTENT NOISE SOURCES

(a) Steam Venting to Atmosphere

<u>Problem</u>: Estimate the sound power level created by the venting of high pressure steam to the atmosphere; in particular from electromatic valves and steam line blowouts. The former noise source will be analyzed here.

<u>Solution</u>:

Step 1: Select an empirical model developed in 1973 to predict the sound power generated when high pressure gas or steam expands to atmospheric pressure through a valve[C6].

Step 2: The empirical equation used depends upon whether the pressure ratio across the valve (P_S/Patm) is greater or less than 7.4. The steam pressure upstream of the electromatic valves upon release will be P_S = 2995. psia while atmospheric pressure is roughly 14.7 psia. Clearly their ratio is greater than 7.4 (as it is for the line blowouts at 815. psia) so that the appropriate sound power level equation is:

$$SWL = 118 + 10 \log_{10} P + 5 \log_{10} (T/MW) + 10 \log A \quad dB \qquad C-6$$

Where: P = system pressure in psfa
= 2995 psia x 144 $in.^2/ft.^2$ = 4.31×10^5 psfa,
T = system temperature (°R)
= 546°C = 1474°R
MW = molecular weight
= 18 for pure steam (H_2O)
A = valve flow area in $ft.^2$
= 3.41×10^{-2} $ft.^2$ for valve with 2.5 in. inlet.

Therefore the total sound power level of a single electromatic valve is:

$$SWL = 118 + 10 \log_{10} (4.31 \times 10^{5}) + 5 \log_{10} (1474/18) + 10 \log_{10} (0.0341)$$
$$= 118 + 56.3 + 9.6 - 14.7 \quad dB$$
$$= 169.\ dB\ re.\ 10^{-12}\ W.$$

Step 3: Estimate the spectrum of the steam-venting noise. IN cases like this one where P_s/Patm is greater than ten, the spectrum will contain a peak near 2000 Hz with a level about 5 dB down from the total SWL (i.e. 164 dB). The spectrum will roll off on both sides of this peak at a rate of from 3 to 5 dB/octave (assume 4 dB/octave). The spectra for two simultaneous electromatic valves and three line blowout valves (the usual procedures) are:

SWL re 10^{-12}W

	31.5	63	125	250	500	1K	2K	4K	8K
2 Electromatic valves	143	147	151	155	159	163	167	163	159
3 Blowout valves	151	155	159	163	167	171	175	171	167

(b) Pit Blasting Noise

Problem: to predict peak linear sound pressure level at 30 m (100 ft.) from the effective acoustic centre of a pit blast.

Solution:

Step 1: Select an empirical blasting noise model which allows peak SPL to be estimated on the basis of the total weight of the explosive surface charge (W). The model selected provides a first approximation to the peak SPL when (1) the denotated explosion is an open air shot and (2) the peak overpressure at the reference distance D is less than 1 psi (170 dB)[C7]. To meet the second criterion, it was necessary to use a 30 m (100 ft.) reference distance instead of the usual 15 m (30 ft.). The peak SPL expression is:

$$\text{Peak SPL} = 209 - 24 \log_{10} D + 8 \log_{10} W \quad \text{dB} \qquad \text{C-7}$$

Step 2: An estimate of the size of the typical surface charge to be at Open Pit No. 1 was detained from the Mining Department, Thermal Division of B.C. Hydro. The blasting program calls for the total length L of primer cord (25 grains/ft. of PETN) to be roughly 3000 m (10,000 ft.) per week. The maximum frequency of blasting will be once per day with once or twice per week being the goal. From the point of view of yearly noise exposure, the once per day case is the worst case so that it will be addressed here. The daily blast will then use 1/7 of the week's allotment of primer cord, that is L = 346 m (1430 ft.). Therefore:

$$W = \frac{L.g}{5760} \text{ lbs.}^{C7} \qquad \text{C-8}$$

Where, g is the number of grains/ft of the primer cord.

Here: $W = \frac{1430 \cdot 25}{5760}$ lbs.

$= 6.2$ lbs.

Therefore: D = 30 m (100 ft.):

Peak SPL $= 209 - 24 \text{ Log}_{10} (100) + 8 \text{ Log}_{10} (6.2)$

$= 167.$ dB

Step 3: Estimate the octave band spectrum of blasting noise. Measurements taken of blasting at Trench A of bulk sample program were used to establish an indicative spectrum shape, although it is appreciated that blasting spectra will vary somewhat with type of primer cord and perhaps ground surface. The resulting blasting noise spectrum at 30 m (100 ft.) was:

	OCTAVE BAND CENTRE FREQUENCIES (Hz)								
	31.5	63	125	250	500	1K	2K	4K	8K
SPL re 20 µPa (167 dB peak)	165	163	161	157.5	153	150	150	155	160

C1.4 CHARACTERIZATION OF DISTRIBUTED NOISE SOURCES (MINE)

Problem: Several project noise sources regions, such as the mine and the North Valley waste dump, are physically large compared to the distances from their borders to the nearest noise receptor location. Therefore, these regions cannot simply be treated as point sources of sound when computing the attenuation of their noise levels with distance due to geometric spreading [see Section 4.1 f (i) in the text]. The task then was to develop a simplified (engineering estimate) method of predicting the noise levels in the near field of a large noise source region such as Open Pit No. 1.

Solution:

Step 1: As described in Section 4.3 b (i) of the text, the pit and superficial activities are assumed, on a yearly-averaged basis, to be spatially uniform over the entire surface of the pit, so that a uniformly-distributed noise source region is created. The entire surface area of the pit can then be considered to be uniformly covered with simple (point) acoustic sources.

Step 2: Consider, for example, that during Mine Stage 6, the site of the pit and the distance from it to the group of ranch houses at the confluence of the Medicine and Hat Creeks are as shown in Figure C1-2. The nearest edge of the pit is 975 m (3200 ft.) from the ranch houses while the farthest is 3290 m (10,800 ft.) away.

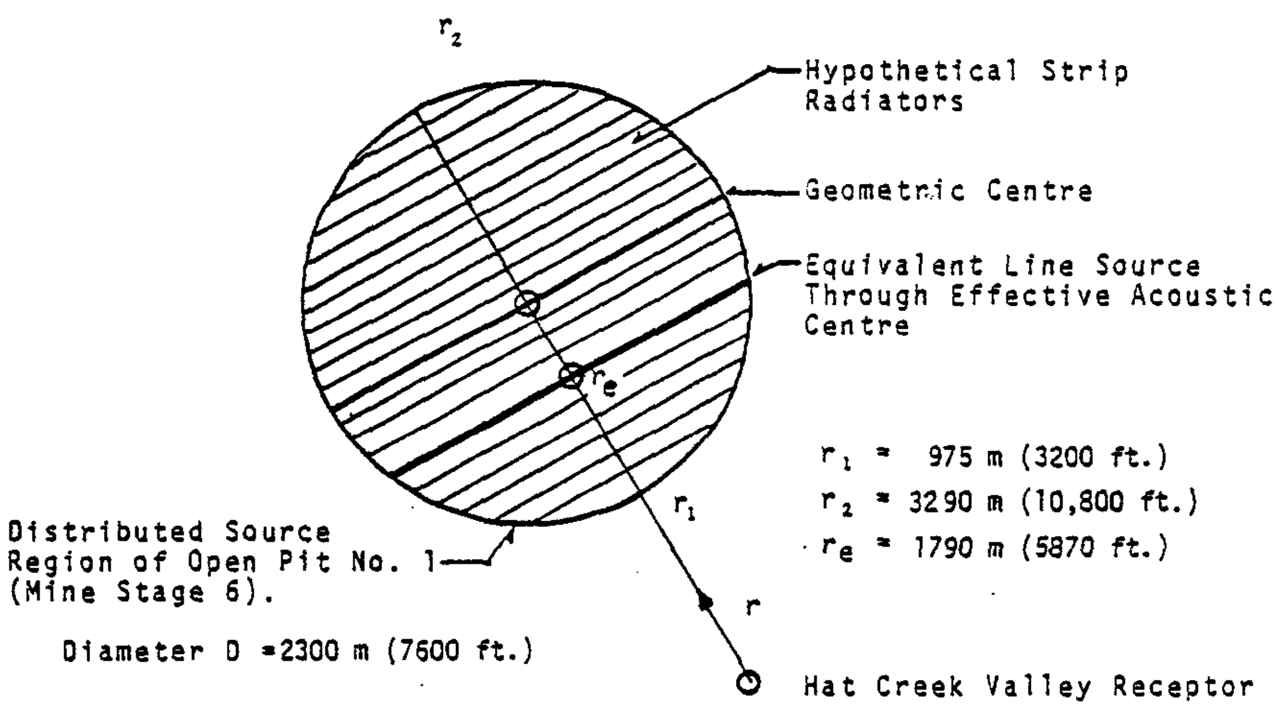

FIGURE C1 - 2: STYLIZED REPRESENTATION OF OPEN PIT NO. 1 WITH RECEPTOR IN NEAR FIELD (r_1<D)

Step 3: The acoustic intensity of a spherical sound source in a half plane (i.e. on the ground) is given by C[8]:

$$I = \frac{\rho c k^2}{8\pi^2 r^2} Q^2 \qquad \text{C-9}$$

$$= C\left(\frac{Q}{r}\right)^2$$

where, r = distance from source to receptor

Q = strength of spherical source

= surface area of source times its velocity

and $C = \frac{\rho c k^2}{8\pi^2}$ where ρ is the density of air, c the speed of sound in air, and k the wave number = 2πf/c where f is frequency.

If it is assumed that the uniform acoustic source strength of the pit area is Q then the total acoustic intensity reaching the receptor at distance r is equal to the integral of Eqtn C-9 over the surface of the mine. An easier way to deal with the problem is to consider the mine to be divided up into many strips perpendicular to the sound path to the receptor (see Figure C-2). Since the mine is roughly symmetrical, each strip will radiate roughly the same sound energy, and the distance from the effective acoustic centre of the mine to the particular receptor in question can be found by performing the much simpler integration of Eqtn C-9 with respect to distance along the line from the receptor through the geometric centre of the pit. The effective acoustic centre of the pit is an acoustic line source at which, if the total acoustic source strength of the mine were concentrated, the sound pressure level at the receptor location would be the same as it is from the actual distributed noise source. If we then consider that each strip of the mine area has the sound source strength Q′ per unit length in the direction of the source-receptor path, then the total sound intensity reaching the receptor from the effective acoustic centre is given by:

$$I_{tot.} = \frac{C\,(Q')^2}{r_e^{\,2}}(r_2 - r_1) \qquad \text{C - 10}$$

Where, r_e = distance from receptor to effective acoustic centre

r_1, r_2 = distances from receptor to near and far edges of the pit.

We must obtain the same total intensity, if Eqtn C-9 is integrated across the width of the pit:

$$I_{tot.} = \int_{r_1}^{r_2} \frac{C\,(Q')^2}{r^2}\,dr$$

$$= C(Q')^2 \int_{r_1}^{r_2} \frac{dr}{r^2} = C(Q')^2 \left[\frac{-1}{r}\right]_{r_1}^{r_2}$$

$$= \frac{C(Q')^2}{r_1}\left(1 - \frac{r_1}{r_2}\right) \qquad \text{C-11}$$

Equating the two expressions for $I_{tot.}$ from Eqtns C-10 and C-11 and solving for $r_e^{\,2}$, we have

$$r_e^{\,2} = \frac{r_1(r_2 - r_1)}{1 - \frac{r_1}{r_2}} = \frac{r_1\, r_2\, (r_2 - r_1)}{r_2 - r_1}$$

$$r_e = (\,r_1\ r_2\,)^{1/2} \qquad \text{C-11}$$

Therefore, in the case of the pit during Mine Stage 6 where r_1 = 975 m (3200 ft.) and r_2 = 3290 m (10,800 ft.) the distance from the receptor to the line source which effectively represents the distributed source region of the pit is:

$$r_e = (975 \cdot 3290)^{1/2} \text{ m}$$

$$= 1790 \text{ m (5870 ft.)}$$

Whereas the distance to the geometric centre of the pit to the receptor is 975 + 3290/2 = 2620 m (8590 ft.). Therefore, the error to be incurred by considering the acoustic centre to be at the geometric centre would have been considerable especially when air absorption over the difference of 830 m (2720 ft.) is considered.

The mine can then be considered to be an acoustic line source of length to the diameter of the roughly circular pit and can be dealt with in usual way of line sources like highways or road construction zones.
That is:

1. If the receptor to effective acoustic centre distance r_e is less than the length of the line source L, the radiating surface will be considered to be semi-cylinder length L. The geometric spreading rate is that of a line source, i.e. proportional to $\frac{1}{r}$.

2. If r_e is greater than L, then the radiating surface is considered to be a hemisphere and the geometric spreading is proportional to $\frac{1}{r^2}$

REFERENCES

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C3. Teplitzky, A.M. 1977. Estimating cooling tower sound *Emission levels. Power Engineering. September 58-61.*

C4. Shulz, M.W. General Electric. 1976. Paper presented orally at Summer Conference of the IEEE Power Engineering Society in Portland, Oregon on July 17, 1976.

C5. Acoustical Engineering (now Harford, Kennedy, Wakefield Ltd.). 1975. Vancouver International Airport Aeronautical Noise Study.

C6. Anderson, R.E. 1973. Blowdown Noise-Analysis and Control. Paper presented at the 85th meeting of the Acoustical Society of America. April 1973.

C7. Suuronen, D.E. 1974. Noise Measurement from Dynamite Blasting. Proceedings of Inter-noise 74., Institute of Noise Control Engineering. pp. 533-536.

C8. Kinsler, L.E. and A.R. Frey, 1950. Fundamentals of Acoustics. John Wiley and Sons Inc., New York. p. 173.

C9. Ver, I.L. and C.I. Holmer. 1971. Interaction of Sound Waves *with Solid Structures. Chapter 11 in L.L. Beranek ed. Noise* and Vibration Control. McGraw-Hill, New York. p. 283.

APPENDIX D

NOTES FROM JANUARY 6, 1977 MEETING

acoustical engineering
CONSULTING ENGINEERING DIVISION OF
AERO ACOUSTIC SYSTEMS LTD.

File: 72-161-1

NOTES FROM MEETING JANUARY 6, 1977

Attending: K.D. Harford - Aero Acoustic Systems Ltd.
B. Hall - Strong Hall & Associates

1) Information Exchanged:

- K.D.H. gave Strong Hall copies of traffic counts obtained during noise monitoring.

2) Discussion:

a) at this stage of the project studies, the present land use will have to be considered as indicative of the highest and best use of the land - possible exceptions include potential agricultural, recreational or mining uses.

b) Strong Hall has requested origin and destination information from Hydro and traffic counts from Dept. of Highways. AASL to provide S.H.A. with requirements for traffic data, and SHA will do forecasting. AASL will need this data very soon, thus the o/d information from Hydro is urgently needed by SHA.

c) Costs of Noise Impact - General Methodology

Noise impact could possibly fall within 2 categories:

1. where there is an incremental impact due to raising the background noise levels above there present levels, but the land use remains compatible. Except where traffic noise is to increase in future, future noise levels without the project will be considered as remaining at the present levels.

2. where the noise level increases to the point where the land use is incompatible.

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c) Costs of Noise Impact - General Methodology (cont'd)

A) where B.C. Hydro purchases property in the first category, the difference between the purchase price and the present value of future revenue from the land would be a cost attributible to the total project cost account and would not be broken down to assign an amount to noise unless noise is shown to be the only motivation for purchasing the property.

B) where B.C. Hydro purchases property in the second category, the difference between the purchase price and the present value of the future revenues:

a) with noise modifying land use, and

b) without noise

would be assigned as a noise impact cost. As in A above, where there is a difference between the purchase price and the future revenues even without noise, this cost would be attributed to the total project costs.

C) where B.C. Hydro does not purchase affected properties (most significantly the Indian Lands) it will be necessary to do the following analysis:

1. determine the highest and best use of the land in question.
2. establish noise compatibility criteria for this use
3. evaluate project noise levels relative to the compatability criteria
4. where noise levels and land use are incompatible, the lower value of use that is compatible would be considered and the cost of the noise impact considered as the difference between the values of the highest and best use, and the lower compatible use.
5. where the noise levels are considered compatible with the highest and best use, but the plant and mine noises will increase the ambient noise levels of the area, the incremental increase in the noise level will be identified, and the possible means of mitigation presented. However it will not be possible to delineate the costs of this impact quantitatively.

c) Costs of Noise Impact - General Methodology (cont'd)

D) in the purchase of property by B.C. Hydro, it would be useful if the purchase price could be broken down into the amount paid for the agricultural and the residential components of each property.

E) in the case of areas affected by an incremental noise impact, but where the land use is still compatible, it will ultimately be necessary to rank noise relative to the other impacts for the area. As this will be a qualitative appraisal, it is likely that a group discussion using a technique such as the Delphi process will be necessary.

F) mapping the existing and potential land use of the affected areas is apparently within TERA's terms of reference, and thus AASL should obtain this information from TERA.

APPENDIX E

MINE PIT BLASTING VIBRATION

APPENDIX E

MINE PIT BLASTING VIBRATION

Blasting operations in the mine pit will result in ground vibration which could be a source of annoyance upon its severity. The most important parameters affecting ground vibration are the scaled distance from the blast and the nature of the ground through which the vibration propagates. Scaled distance is defined as the actual distance from source to receiver in feet divided by the square root of the maximum weight of explosives, in pounds, per delay*.

Criteria for ground vibration from blasting are generally expressed in terms of peak particle velocity as noted below:

Peak Particle Velocity (in/sec.)	Effect
0.03 - 0.1	Perceptible but not annoying to most people
0.1 - 0.2	Complaints possible
0.2 - 2.0	Severe, complaints likely
2.0	Damage to residential structures possible

The above criteria represent a concensus of opinion from various reference on the subject.[1,2,3,4]

---

* Short delay detonators (e.g. 25, 50, 75 millisecs) are commonly used to divide each blast into a number of smaller successive blasts. This results in better fragmentation of rock and also lower peak levels of noise and vibration.

The amplitude of ground vibration at the nearest residential dwelling has been predicted based on the expected and a range of different attenuations.

The prediction was made as follows:

1. The distance from the head of the conveyor incline to the nearest residential dwelling on Bonaparte Indian Reserve 1 is approximately 1 mile.
2. *The expected charge per delay is 500 -1000 lbs*[5]. Therefore, 1000 lbs. has been assumed.
3. Combined data from blasting studies at thirteen different quarries is presented in Figure 4.22 of Reference 1 . Using a scaled distance of $5000 \text{ ft.}/(1000 \text{ lbs.})^{1/2} = 160$. The resultant peak particle velocity could range from approximately 0.02 to 0.1 in./sec. The lower limit is one standard deviation below the mean value for the quarry at which measured vibration was least and the upper limit is one standard deviation above the mean value for the quarry at which measured vibration was the greatest.

By comparing the predicted values to the criteria presented previously, it becomes apparent that ground vibration from pit blasting, at a maximum of one blast per day, is unlikely to result in annoyance.

REFERENCES

1. Nicholls, H.R., C.J. Johnson, and W.I. Duvall. 1971. Vibrations and their Effects on Structures, Buslines Bulletin 656

2. Oriard, L.L. Blasting Operations in the Urban Environment, reprint from Blasting Journal.

3. Berger, P.R. Blasting Controls and Regulations, Reprint from Mining Congress Journal.

4. Brown, L.M. 1971. Measurements of Vibration caused by Construction Equipment and Blasting, Ontario Department of Highways Report No. RR172

5. Personal Communication. Harford, Kennedy, Wakefield Ltd. Telephone Conversations on April 14, 1978, D.S. Kennedy to J.J. Fitzpatrick of B.C. Hydro.

APPENDIX F

IMPACT MATRICES

TABLE OF CONTENTS

F1-0 INTRODUCTION

The impact matrices contained in this appendix serve two primary purposes:

1. to summarize both the project noise impacts in terms of their location, extent, severity and cause, and the actions which should be taken to mitigate and/or compensate for those impacts judged to be of significance.

2. to provide a common basis and terminology through which the various types of environmental impact (as predicted by the various detailed environmental studies consultants) can be compared and combined.

The terminology used and the matrix format followed herein are as specified by Ebasco Services Canada Ltd., Environmental Consultants in their "Environmental Impact Assessment Procedure" for the Hat Creek Project. This terminology is summarized below:

1. Impact Areas:

   The overall study area has been broken down into "impact areas" to aid in localizing impacts. These are as follows:

   A - impact area A includes the site and environs (the area of primary project development)

   B - between the site and the surrounding major topographic barriers; 10-30 km. (6 - 19 miles)

   C - the area encompassing major nearby communities; 30-40 km. (19 - 25 miles)

   D - the approximate boundary of air contaminant dispersal effects; 100 km. (62.5 miles)

To provide further geographical distinctions, impact areas B, C and D have been divided into quadrants numbered 1, 2, 3, 4 starting with the northwest quadrant and moving clockwise.

2. "Amount" of Resource Impacted

Impact is defined as a change in a resource. The amount of a resource affected or changed in a given area is specified in appropriate units; in the case of noise impact, these units may be numbers of people, homes or area of land.

3. Per Cent of Resource

Where possible, the amount of impacted resource is expressed in terms of its percentage of the total amount of that resource in the impact area.

4. Limits of Accuracy

In presenting the amount of resource impacted, the accuracy with which this amount has been predicted is expressed by the following scale:

D - Determined; a precise value is given based on calculation or measurement.

R - Range; no exact single-value can be provided but precise limits can be established.

P - Predicted; neither an exact value or range of values can be provided, but a value is given based on limited knowledge, known relationships, etc.

M - Limited information available; a value given based on an assumed set of conditions.

O - Opinion; value provided without any supporting data but represents best judgement of the consultant.

I - Indeterminant; no amount given because it cannot be determined.

U - Undetermined; no amount given because it has not been determined.

5. Existing Quality

By specifying the quality of the existing resource relative to that of the universe of that resource (here the universe is considered to extend to the largest impact Area, D), the significance of a given impact can be better appreciated. The scale of quality is as follows:

O - Outstanding; unique, scarce

H - High; much above average quality

G - Good; average quality

F - Fair; somewhat below average quality

P - Poor; substantially below average quality

I - Indeterminant; quality cannot be determined

U - Undetermined; quality has not been determined.

6. Impact Significance

The overall significance of a project impact is, in general, based on a judgement which follows a careful evaluation of the amount and quality of a resource before and after project actions. In the specific case of noise impacts, there is also the consideration of "level" of impact, i.e. the severity of the change in noise environment to which man or animal is exposed. The quantification of environmental noise levels with and without the project allows these impact levels to be determined.

For the major area of concern, i.e. the impact of project noise on residential areas, three scales of impact significance have been based on the increase in environmental noise level due to the project: two which reflect the adverse effects of noise on the public health and welfare in areas which have or will have noise levels incompatible with residential land use, and one which reflects the probable severity of public reaction to intruding project noise of all identifiable levels. These three scales are described in Section 6.7 of the text and appear in Tables 6-7, 6-8 and 6-9. The project noise impact significance at a particular receptor location, as given in the following matrices, has been taken as the higher of the two levels of significance predicted based on public health and welfare effects and on expected community reactions. (See section 6.7)

Noise impact significance in residential areas has then been based solely on the increase in noise level caused by the project and on the probable community reaction to such increase. The actual number of people or homes impacted has not entered directly into the process except where this aids in the comparison of project alternatives. The "quality of the resource" corresponds here to the existing environmental noise level and this is accounted for in the determination of probable community reaction.

In other areas, such as noise impact on cattle grazing land use, the impact significance is based on resource quality, amount impacted and its percentage of the local resource universe.

The scales of impact significance in all cases contain the following categories:

E - Extreme
H - High
M - Moderate
L - Low
I - Insignificant

7. <u>Types of Impact Matrices</u>

Three types of impact matrices are used herein.

a) Overall Project Impact Matrix:

- One such matrix prepared for each impact area in which a significant impact is foreseen. These matrices cover all major stages and components of the project and summarize the amount of impacted resource, its pre-project quality, and the impact significance.
- Blank spaces on these matrices indicated that no impact was caused by a given project component in a given impact area.

b) Matrix Form M-1

These forms provide summaries of the amount, percentage of resource, resource quality and impact significant for the various project impacts which will occur in a given impact area during a particular project phase, i.e. construction, operation or decommissioning. Where the impact significance of a project phase varies through more than one category, the range has been indicated by dashes. The single category which is felt to be most representative of the overall project noise impact significance has been indicated with a check mark. Backup information is attached to the forms giving comments and text references.

c) Matrix Form M-2

These forms serve to summarize all recommendations for the mitigation of and/or compensation for those project impacts which are judged to be either moderate, high or extreme. Again, the forms are accompanied by backup information.

F2-0 OVERALL PROJECT NOISE IMPACT MATRICES

IMPACT AREA C3		CONSTRUCTION (FIRST YEAR OF EACH ACTIVITY)										OPERATION (MINE STAGE 6)										DECOMMISSIONING		
		MINE	PLANT			OFFSITES						MINE		PLANT		OFFSITES						MINE	PLANT	OFFSITES
RESOURCE IMPACTED		NORTH VALLEY DUMP +MINE MOUTH FAC.	SITE PREP +FOUNDTN.	BLASTING	STEAMLINE BLOWOUTS	WATER INTAKE	PUMPING STN. 1	WATER PIPELINE	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	PIT + COAL PREP	BLASTING	CONTINUOUS SOURCES	ELECTROMATIC VALVE	PUMPING STN. 1	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	69 KV TRANSFRM	ASHCROFT OFFLOAD. FACILITY	PIT + DUMPS		PUMPING STN. 1
a) RESIDENTIAL LAND USE																								
1. Thompson-Bonaparte Confluence	amount quality impact					6 Homes F LOW	6 Homes F MOD	6 Homes F INSIG.								6 Homes F MOD.								6 Homes F MOD.
2. North Ashcroft Subdivision	amount quality impact							(U) G LOW													(U) G LOW			
b) COMMUNITY REACTION																								
1. Thompson - Bonaparte Confluence	amount quality impact					6 Homes F MOD	6 Homes F MOD									6 Homes F HIGH.								6 Homes F LOW
2. North Ashcroft Subdivision	amount quality impact							(U) G LOW													(U) G INSIG.			

June 5, 1978

PROJECT NOISE IMPACT MATRIX FOR IMPACT AREA "C3"

Harford, Kennedy, Wakefield Ltd.

IMPACT AREA A		CONSTRUCTION (FIRST YEAR OF EACH ACTIVITY)										OPERATION (MINE STAGE 6)										DECOMMISSIONING		
		MINE	PLANT			OFFSITES						MINE		PLANT		OFFSITES						MINE	PLANT	OFFSITES
RESOURCE IMPACTED		NORTH VALLEY DUMP +MINE MOUTH FAC.	SITE PREP +FOUNDTN	BLASTING	STEAMLINE BLOWOUTS	WATER INTAKE	PUMPING STN. 1	WATER PIPELINE	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	PIT + COAL PREP	BLASTING	CONTINUOUS SOURCES	ELECTROMATIC VALVE	PUMPING STN. 1	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	69 KV TRANSFRM	ASHCROFT OFFLOAD. FACILITY	PIT + DUMPS		PUMPING STN. 1
a) RESIDENTIAL LAND USE																								
1. Bonaparte Reserve 1	amount quality impact	1 Home, 4-6People G LOW									6 Homes G INSIG.	1 Home G LOW							6 Homes G INSIG.					
2. Hat Creek Valley Ranches																								
-M. Saulte & I. Lehman	amount quality impact											2 Homes H-O LOW												
b) GRAZING LAND USE																								
1. Hat Creek Valley Ranches	amount quality impact	1.0 km.² H INSIG.										6.5 km.² H MOD												
2. Trachyte Hills	-do-													3.4 km² LOW										
c) COMMUNITY REACTION																								
1. Bonaparte Reserve 1	amount quality impact	6 Homes 25 -35 Peop G MOD	6 Homes G INSIG.	6 Homes G INSIG.	6 Homes G INSIG.						6 Homes G INSIG.	6 Homes G MOD	6 Homes G INSIG.	6 Homes G LOW	6 Homes G INSIG.				6 Homes G INSIG.			6 Homes G LOW	6 Homes G INSIG.	
2. Hat Creek Valley Ranches																								
- Ed Lehman	amount quality impact	1 Home H-O MOD		1 Home H-O INSIG.	1 Home H-O INSIG.																			
- M. Saulte & I. Lehman	amount quality impact	2 Homes H-O LOW	2 Homes H-O INSIG.	2 Homes H-O INSIG.	2 Homes H-O INSIG.							2 Homes H-O EXTREME			2 Homes H-O INSIG.							2 Homes H-O LOW	2 Homes H-O INSIG.	
- A Parke & D. Ridlar	amount quality impact	2 Homes H-O INSIG..	2 Homes H-O INSIG.	2 Homes H-O INSIG.	2 Homes H-O INSIG.							2 Homes H-O MOD		2 Homes H-O LOW	2 Homes H-O INSIG.							2 Homes H-O INSIG.	2 Homes H-O INSIG.	
- A. Pocock & G. Parke	amount quality impact											2 Homes H-O INSIG.		2 Homes H-O INSIG.	2 Homes H-O INSIG.									

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PROJECT NOISE IMPACT MATRIX FOR IMPACT AREA "A"

Harford, Kennedy, Wakefield Ltd.

IMPACT AREA B2, B4		CONSTRUCTION (FIRST YEAR OF EACH ACTIVITY)										OPERATION (MINE STAGE 6)										DECOMMISSIONING		
		MINE	PLANT			OFFSITES						MINE		PLANT		OFFSITES						MINE	PLANT	OFFSITES
RESOURCE IMPACTED		NORTH VALLEY DUMP +MINE MOUTH FAC.	SITE PREP +FOUNDTN	BLASTING	STEAMLINE BLOWOUT	WATER INTAKE	PUMPING STN. 1	WATER PIPELINE	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	PIT + COAL PREP	BLASTING	CONTI-NUOUS SOURCES	ELECTRO-MATIC VALVE	PUMPING STN. 1	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	69 KV TRANSFRM	ASHCROFT OFFLOAD. FACILITY	PIT + DUMPS		PUMPING STN. 1
AREA B2																								
a) COMMUNITY REACTION																								
Bonaparte Reserve 2	amount quality impact										7 homes G Insig.								7 Homes G Insig.					
b) GRAZING LAND USE																								
1. McLean Lake Reserve	amount quality impact									3.7 ha-mos/ km. road F Insig.														
2. Open Range Land (Cornwall Hills)	amount quality impact									14 ha.mos/ km. road F Insig.														
AREA B4																								
RECREATIONAL LAND USE																								
Clear Range	amount quality impact											I H MOD												

June 5, 1978

PROJECT NOISE IMPACT MATRIX FOR AREAS B2 AND B4

IMPACT AREA C1, C2		CONSTRUCTION (FIRST YEAR OF EACH ACTIVITY)										OPERATION (MINE STAGE 6)										DECOMMISSIONING		
		MINE	PLANT			OFFSITES						MINE		PLANT		OFFSITES						MINE	PLANT	OFFSITES
RESOURCE IMPACTED		NORTH VALLEY DUMP +MINE MOUTH FAC.	SITE PREP +FOUNDTN	BLASTING	STEAMLINE BLOWOUT	WATER INTAKE	PUMPING STN. 1	WATER PIPELINE	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	PIT + COAL PREP	BLASTING	CONTI-NUOUS SOURCES	ELECTRO-MATIC VALVE	PUMPING STN. 1	AIRSTRIP SITE C	ACCESS ROAD	HWY. 12 TRAFFIC	69 KV TRANSFRM	KELLY LK. OFFLOAD. FACILITY	PIT + DUMPS		PUMPING STN. 1
AREA C1																								
a) RESIDENTIAL LAND USE																								
Kelly Lake	amount quality impact																				U F-G LOW			
b) COMMUNITY REACTION																								
Kelly Lake	amount quality impact																				U F-G Insig.			
AREA C2																								
a) RESIDENTIAL LAND USE																								
Airstrip Site C	amount quality impact								U F LOW								U F LOW							
b) COMMUNITY REACTION																								
Airstrip Site C	amount quality impact								U F Insig.								U F Insig.							

June 5, 1978

PROJECT NOISE IMPACT MATRIX FOR AREAS C1 AND C2

Harford, Kennedy, Wakefield Ltd.

F3-0 MATRIX FORMS M-1

FORM M-1

MATRIX 1 FOR AREA A SHEET 1

PHASE: CONSTRUCTION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING QUALITY	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE		EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE								
Bonaparte Reserve 1	1 Home, 4-6 People (R)	16	G				✓	
b) GRAZING LAND USE								
Hat Creek Valley Ranches	1.0 km.^{2} (0.4 sq. miles) (R)	1.2	H					✓
c) COMMUNITY REACTION								
1. Bonaparte Reserve 1	6 Homes, 25-35 People (R)	100%	G		--	✓	--	--
2. Hat Creek Valley Ranches								
-Ed Lehman	1 Home (R)	14	H-O			✓		
-M. Saulte, I. Lehman.	2 Homes (R)	28	H-O				✓	
-A. Parke & D. Ridlar	2 Homes (R)	28	H-O					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 1, AREA A, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Bonaparte Reserve 1	Home near Highway 12 like most reserve homes.	p. 6-9, Table 6-10
b) GRAZING LAND USE		
Hat Creek Valley Ranches	Part of this land will be within range of security fencing.	pp. 6-13, 6-58
c) COMMUNITY REACTION		
1. Bonaparte Reserve 1	Homes all quite near Highway 12, exposed to varying levels of project noise.	p. 6-10, Table 6-10
2. Hat Creek Valley Ranches:	10 occupied houses in valley as of March 1978	
-Ed Lehman	Very low existing noise levels (YDNL 35-40)	p. 6-12, Table 6-10
-M. Saulte, I. Lehman, A. Parke and D. Ridlar	Very low existing noise levels (YDNL 35-40)	p. 6-12, Table 6-10

FORM M-1

MATRIX 2 FOR AREA A SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING QUALITY	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE		EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE								
1. Bonaparte Reserve 1	1 Home, 4-6 People (R)	16	G				✓	
2. Hat Creek Valley Ranches:								
-M. Saulte & I. Lehman	2 Homes (R)	20	H-O				✓	
b) GRAZING LAND USE								
-Hat Creek Valley Ranches	3.9 km.^{2} (1.5 sq. miles) (R)	4.3	H			✓		
-Trachyte Hills	3.4 km.^{2} (1.4 sq. miles) (R)	3	10% H 90% P				✓	
c) COMMUNITY REACTION			G			✓		
1) Bonaparte Reserve 1	6 Homes 25-35 People (R)	100	G		--	✓	--	
2. Hat Creek Valley Ranches:								
-M. Saulte & I. Lehman	2 Homes	20	H-O	✓				
-A. Parke	1 Home	10	H-O			✓		
-D. Ridlar	1 Home	10	H-O			✓		
-A. Pocock & G. Parke	2 Homes (R)	20	H-O				--	✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 2, AREA A, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
1. Bonaparte Reserve 1	Home near Highway 12 like most reserve homes.	p. 6-33, Table 6-11
2. Hat Creek Valley Ranches:	Very low existing noise levels.	
-M. Saulte & I. Lehman	Homes may be physically displaced by Creek Diversion Facilities.	p. 6-36, Table 6-11
b) GRAZING LAND USE		
- Hat Creek Valley Ranches	Some of land will be within range fence. Land will not be lost to grazing entirely, but productivity will be reduced to an indeterminate degree.	pp. 6-37, 6-58
- Trachyte Hills	With quieter fan selection, impacted area would be greatly reduced. Only 10% of area is high quality spring grazing land, the rest is poor.	pp. 6-38, 6-58
c) COMMUNITY REACTION		
1. Bonaparte Reserve 1	Homes all quite near Highway 12. Exposed to various levels of project noise (YDNL 44-61).	p. 6-34, Table 6-11
2. Hat Creek Valley Ranches:		
-M. Saulte & I. Lehman	Very low existing noise levels (YDNL 35-40)	p. 6-38, Table 6-11
-A. Parke	Very low existing noise levels (YDNL 35-40)	
-D. Ridlar	Very low existing noise levels (YDNL 35-40)	
-A. Pocock and G. Parke	Very low existing noise levels (YDNL 35-40)	

FORM M-1

MATRIX 3 FOR AREA A SHEET 1

PHASE DECOMMISSIONING PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
COMMUNITY REACTION								
1. Bonaparte Reserve 1	6 Homes, 24-36 People (M)	100	G				✓	
2. Hat Creek Valley Ranches								
-M. Saulte & I. Lehman	2 Homes	20	H-O				✓	
-A. Parke	1 Home	10	H-O					✓
-D. Ridlar	1 Home (M)	10	H-O					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 3, AREA A, PHASE DECOMMISSIONING

RESOURCE	COMMENTS	TEXT REFERENCES
COMMUNITY REACTION		
1. Bonaparte Reserve 1	Assume mine decommissioning noise 20 dBA lower than mine operating (Stage 6) noise. Assume plant decommissioning noise same as during construction (1978-79).	pp. 4-58, 6-51
2. Hat Creek Valley Ranches:	-Assumptions as above.	
-M. Saulte and I. Lehman	-May not be occupied at this stage.	pp. 4-58, 6-51
-A. Parke		
-D. Ridlar		

FORM M-1

MATRIX 4 FOR AREA B2 SHEET 1

PHASE CONSTRUCTION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING QUALITY	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE		EXTREME	HIGH	MOD.	LOW	INSIG.
a) COMMUNITY REACTION								
Bonaparte Reserve 2	7 Homes 28-42 People (R)	100	G					✓
b) GRAZING LAND USE								
1. McClean Lake Reserve	3.7 hectare-months (9 acre-months) (R)	< 1.0 (based on one year)	F					✓
2. Open Range Land (Corwnall Hills)	14 hectare-months (35 acre-months) per km. of access road. (R)	< 1.0 (based on one year)	F					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 4, AREA B2, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) COMMUNITY REACTION		
Bonaparte Reserve 2	Highway 12 project-associated traffic noise will cause YDNL to increase by 1.5 dB.	p. 6-11
b) GRAZING LAND USE		
1. McClean Lake Reserve	30 m (100 ft) strip along south edge impacted.	p. 6-25
2. Open Range Land (Cornwall Hills)	At each point along access road route, a 0.8 km (0.5 mile) wide strip will be impacted for about 2 months.	p. 6-25

FORM M-1

MATRIX 5 FOR AREA B4 SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING QUALITY	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE		EXTREME	HIGH	MOD.	LOW	INSIG.
RECREATIONAL LAND USE								
Clear Range	(I)	Roughly 50 (O)	H			✓		

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 5, AREA 84, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
RECREATIONAL LAND USE		
Clear Range	Hiking and horseback riding throughout mountains. Natural noise levels (YDNL 30-40). Mining noise will cause environmental degradation. Physical extent and precise locations of frequented trails not known.	pp. 6-61, 6-7

FORM M-1

MATRIX 6 FOR AREA C1 SHEET 1

PHASE OPERATION OF OFF-LOADING FACILITY PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

KELLY LAKE - POSSIBLE EQUIPMENT OFFLOADING SITE ON BCR.

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE at Kelly Lake	(U)	(U)	F-G				✓	
b) COMMUNITY REACTION at Kelly Lake	(U)	(U)	F-G					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 -6, AREA C1, PHASE OPERATION OF OFFLOADING FACILITY

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE	Residences near Highway through Kelly Lake likely are presently exposed to YDNL 50-60. Therefore, equipment trucking may put some residents over the YDNL 55 criterion.	p. 6-47, Tables 6-7 and 6--8
b) COMMUNITY REACTION	Some prior exposure to trucking noise near highway through Kelly Lake. Total noise sensitivity correction likely zero. Therefore normalized project YDNL likely 51-55 dB.	p. 6-47, Table 6-9

FORM M-1

MATRIX 7 FOR AREA C2 SHEET 1

PHASE CONSTRUCTION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

AIRSTRIP SITE C - SEMLIN VALLEY

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE	(U)	(U)	F				✓	— —
b) COMMUNITY REACTION	(U)	(U)	F					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 7, AREA C2, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
-Near Airstrip Site C	- Existing Traffic Noise levels from Highway 1 are YDNL 49-60. - Number of occupied houses unknown.	p. 6-22, Table 6-10
b) COMMUNITY REACTION		
-Near Airstrip Site C	- Noise Sensitivity Correction is 0 dB.	p. 6-24, Table 6-10

FORM M-1

MATRIX 8 FOR AREA C2 SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

AIRSTRIP SITE C - SEMLIN VALLEY

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE	(U)	(U)	F				✓	— —
b) COMMUNITY REACTION	(U)	(U)	F					✓

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 -8, AREA C2, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
-Near Airstrip Site C	-Highway 1 traffic noise levels during Mine Stage 6 will be YDNL 50-62.	p. 6-42, Table 6-11
	-Airstrip Operation will continue after project is decommissioned.	
b) COMMUNITY REACTION	-Noise sensitivity correction is still 0 dB.	p. 6-43, Table 6-11

FORM M-1

MATRIX 9 FOR AREA C3 SHEET 1

PHASE CONSTRUCTION PREPARED BY HARFORD, KENNEDY WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE								
1. Thompson-Bonaparte Confluence								
-Water Intake	6 Homes 16-18 People (R)	100	F				✓	
-Booster Pumping Station 1	6 Homes, 16-18 People (R)	100	F			✓	--	
2. North Ashcroft Subdivision								
-Water Pipeline	(U)	(U)	G				✓	--
b) COMMUNITY REACTION								
-River Bottom Preparation	6 Homes 16-18 People (R)	100	F					✓
-Water Intake	6 Homes 16-18 People (R)	100	F		--	✓	--	
-Booster Pumping Station 1	6 Homes 16-18 People (R)	100	F		--	✓	--	
2. North Ashcroft Subdivision								
-Water Pipeline	(U)	100	G				✓	--

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 9, AREA C3, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
1. Thompson-Bonaparte Confluence		
- Water Intake	Present YDNL's exceed residential criterion of YDNL 55 due to train traffic. Project noise will cause a 3 to 5 dB increase in these noise levels.	p. 6-16, Table 6-10
- Booster Pumping Station 1	Construction noise will cause a 5 to 8 dB increase in the already incompatible noise levels.	p. 6-17, Table 6-10
b) COMMUNITY REACTION		
1. Thompson-Bonaparte Confluence		
-River Bottom Preparation	Impact will be insignificant over entire area due to low project noise levels and relatively high existing levels.	p. 6-14, Table 6-10
-Water Intake	Higher overall construction noise levels and impulsive pile driver noise will result in moderate impact.	p. 6-16, Table 6-10
-Booster Pumping Station 1	Low to high impact significance over width of residential area; average "moderate"	p. 6-17, Table 6-10
2. North Ascroft Subdivision		
-Water Pipeline	High level of construction activity but very brief duration (2 weeks maximum). Therefore, low impact.	p. 6-18, Table 6-10

FORM M-1

MATRIX 10 FOR AREA C3 SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE								
1. Thompson-Bonaparte Confluence								
-Booster Pumping Station 1	6 Homes, 16-18 People. (R)	100	F			✓	--	
2. North Ashcroft Subdivision								
-Trucking from Offloading Facility	(U)	(U)	G				✓	
b) COMMUNITY REACTION								
1. Thompson-Bonaparte Confluence								
-Booster Pumping Station 1	6 Homes, 16-18 People. (R)	100	F	--	✓	--		
2. North Ashcroft Subdivision								
-Trucking from Offloading Facility	(U)	(U)	G					✓

SUPPORTING INFORMATION FOR:

SHEET 1

MATRIX M-1 -10, AREA C3, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
1. Thompson-Bonaparte Confluence		
-Booster Pumping Station 1	With unsilenced ventilation fans, will have low to moderate impact over the residential area. Already incompatible lands will be made more incompatible.	p. 6-39, Table 6-11
2. North Ashcroft Subdivision		
-Trucking from Off-loading Facility	Assumed route along old highway to Ashcroft-Cache Creek Highway. Existing noise levels are estimated to be YDNL 50-56. Overall impact significance "Low".	Figure 6-3, p. 6-45, Table 6-11
b) COMMUNITY REACTION		
1. Thompson-Bonaparte Confluence		
-Booster Pumping Station 1	Fan and transformer noises will have pure tone components. High impact over southern 50% of area if fans unsilenced.	p. 6-40, Table 6-11
2. North Ascroft Subdivision		
-Trucking from Off-loading Facility	Considered permanet noise, residents have some prior exposure. Therefore, insignificant impact.	p. 6-45, Table 6-11

FORM M-1

MATRIX 11 FOR AREA C3 SHEET 1

PHASE DECOMMISSIONING PREPARED BY: HARFORD, KENNEDY, WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	AMOUNT		EXISTING	IMPACT SIGNIFICANCE				
	ABSOLUTE	% OF RESOURCE	QUALITY	EXTREME	HIGH	MOD.	LOW	INSIG.
a) RESIDENTIAL LAND USE								
1. Thompson-Bonaparte Confluence								
-Water Intake	6 Homes, 16-18 People.	100	F					✓
-Booster Pumping Station 1	6 Homes, 16-18 People. (0)		F			✓	--	
b)								
1. Thompson-Bonaparte Confluence								
-Water Intake	6 Homes, 16-18 People.	100	F					✓
-Booster Pumping Station 1	6 Homes, 16-18 People. (0)	100	F			--	✓	--

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-1 - 11, AREA C3, PHASE DECOMMISSIONING

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
1. Thompson-Bonaparte Confluence	No quantitative information available on decommissioning procedures	
-Water Intake	-Conservatively assume that general level of activity will be same as during construction, but without pile driving; therefore 6 dB down and "Insig." impact.	p. 6-52, Tables 6-1
-Booster Pumping Station 1	-Conservatively assume that impact will be the same as for construction but foundation will be left intact.	p. 6-53, Table 6-10
b) COMMUNITY REACTION		
1. Thompson-Bonaparte Confluence		
-Water Intake	-Assume noise levels same as for construction but without pile driving, and reduce community sensitivity correction by 5 dB because noise associated with removal of former noise source.	p. 6-52, Tables 6-10 5-3 and 6-1.
-Booster Pumping Station 1	-Assume noise levels same as for construction but community sensitivity correction reduced by 5 dB.	p. 6-53 Tables 6-10 5-3 and 6-1

F4-0 MATRIX FORMS M-2

FORM M-2

MATRIX 1 FOR AREA A SHEET 1

PHASE CONSTRUCTION PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE June 5, 1978

RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPT-ABLE LEVEL	MITIGATION AVOID	MITIGATION TIMING	MITIGATION DESIGN	COMPENSATION PRIVATE	COMPENSATION PUBLIC	ENHANCE-MENT
a) RESIDENTIAL LAND USE									
1. Bonaparte Reserve 1	LOW	1 Home, 4-6 People (R)	YDNL 55			✓	✓		
b) COMMUNITY REACTION									
1. Bonaparte Reserve 1	MOD	6 Homes, 25-30 People (R)	Normalized YDNL 55			✓	✓		
2. Hat Creek Valley Ranches									
E. Lehman	MOD	1 Home (R)	Normalized YDNL 55			✓	✓		

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 1, AREA A, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Bonaparte Reserve 1	Mitigation through Design:	
	- selection and maintenance of mobile mining and coal stacking and reclaiming equipment for quiet operation.	p. 7-2
	Compensation:	p. 7-14
	- land exchange or	
	- direct money transfer to single homeowner in non compatible area.	p. 7-14 Appendix D-Item c)C4.
b) COMMUNITY REACTION	Mitigation through Design:	
Bonaparte Reserve 1 and Ed Lehman ranch	- selection and maintenance of mobile mining and coal stacking and reclaiming equipment for quiet operation.	p. 7-2
	- public address system design.	p. 7-5
	- selection and shielding of mine substation transformers.	p. 7-3
	Compensation:	
	- not possible to quantify the monetary compensation (project costs) in this case.	Appendix D-Item c)C5.

FORM M-2

MATRIX 2 FOR AREA A SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE: June 5, 1978

RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPTABLE LEVEL	MITIGATION AVOID	MITIGATION TIMING	MITIGATION DESIGN	COMPENSATION PRIVATE	COMPENSATION PUBLIC	ENHANCEMENT
a) RESIDENTIAL LAND USE									
Hat Creek Valley Ranches									
- M. Saulte & I. Lehman	LOW	2 Homes (R)	YDNL 55			✓	✓		
b) GRAZING LAND USE									
Hat Creek Valley Ranches	MOD	6.2 km^2 (2.4 sq. miles) (R)	YDNL 65			✓	✓		
c) COMMUNITY REACTION									
1. Bonaparte Reserve 1	MOD	6 Homes 25-35 People (R)	Normalized YDNL 55		✓	✓	✓		
2. Hat Creek Valley Ranches									
-M. Saulte & I. Lehman	EXTREME	2 Homes (R)	Normalized YDNL 55		✓	✓	✓		
-A Parke	MOD	1 Home (R)	Normalized YDNL 55		✓	✓	✓		
-D. Ridlar	MOD	1 Home (R)	Normalized YDNL 55		✓	✓	✓		

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 2, AREA A, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Hat Creek Valley Ranches:		
- M. Saulte & I. Lehman	Mitigation Through Design:	
	- selection and maintenance of mobile mining equipment for quiet operation.	p. 7-4
	Compensation:	
	- purchase of properties involved by B.C. Hydro, or direct money transfer	p. 7-14 Appendix D-Items c) B and c) C4
b) GRAZING LAND USE		
Hat Creek Valley Ranches	Mitigation through Design:	
	- selection and maintenance of mobile mining equipment for quiet operation.	p. 7-4
	Compensation:	
	- direct money transfer to land owners, or purchase by B.C. Hydro.	p. 7-14 Appendix D-Items c) C4 and c) B
c) COMMUNITY REACTION		
1. Bonaparte Reserve 1	Mitigation through Design:	
	- selection and maintenance of mobile mining and coal stacking and reclaiming equipment for quiet operation.	pp. 7-4
	- minimize mine public address and signal systems noise levels beyond project boundaries.	pp. 7-5, 7-9
	- judicious selection of induced-draft fans at plant	pp. 7-5, 7-6
	Mitigation through timing:	
	- restrict pit plasting to daytime (8:00 a.m.-5:00 p.m.)	pp. 4-48, 6-11
	Compensation:	
	- not possible to quantify	Appendix D-Item c) C5
	- continued -	

SUPPORTING INFORMATION FOR: SHEET 2

MATRIX M-2 - 2, AREA A, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
c) COMMUNITY REACTION (cont'd.)		
2. Hat Creek Valley Ranches		
-M. Saulte & I. Lehman -A. Parke -D. Ridlar	Mitigation measures as for Bonaparte Reserve 1 Compensation: - purchase of properties involved by B.C. Hydro or, - some, as yet undefined and unprecedented cash payment	Appendix D-Item c) A p. 7-14

FORM M-2

MATRIX 3 FOR AREA B4 SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE: June 5, 197[illegible]

RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPT-ABLE LEVEL	MITIGATION AVOID	MITIGATION TIMING	MITIGATION DESIGN	COMPENSATION PRIVATE	COMPENSATION PUBLIC	ENHANCE-MENT
RECREATIONAL LAND USE									
Clear Range	MOD	(I)	Existing YDNL plus 3 dB			✓		✓	✓

Harford, Kennedy, Wakefield Ltd.

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 3, AREA B-4, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
RECREATIONAL LAND USE		
Clear Range	Mitigation through Design:	
	- selection and maintenance of mobile mining equipment for quiet operation.	p. 7-2
	Compensation:	
	- money transfer to public account; cannot be quantified.	Appendix D
	Enhancement:	
	- if pit is allowed to become a lake after mining completed, lake will provide recreation.	pp. 4-58

FORM M-2

MATRIX 4 FOR AREA C3 SHEET 1

PHASE CONSTRUCTION PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE: June 5, 197[illegible]

RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPTABLE LEVEL	MITIGATION AVOID	MITIGATION TIMING	MITIGATION DESIGN	COMPENSATION PRIVATE	COMPENSATION PUBLIC	ENHANCEMENT
a) RESIDENTIAL LAND USE									
Thompson - Bonaparte Confluence									
-Water Intake	LOW	6 Homes 16-18 People (R)	YDNL 55	✓		✓			
-Booster Pumping Station 1	LOW - MOD	6 Homes 16-18 People (R)	YDNL 55	✓		✓			
b) COMMUNITY REACTION									
Thompson - Bonaparte Confluence									
-Water Intake	MOD	6 Homes 16-18 People (R)	Normalized YDNL 55	✓		✓			
-Booster Pumping Station 1	MOD	6 Homes 16-18 People (R)	Normalized YDNL 55	✓		✓			

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 4, AREA C3, PHASE CONSTRUCTION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Thompson-Bonaparte Confluence		
-Water Intake	Mitigation through Avoidance:	
	- locate intake further up-river away from residences	
- Booster Pumping Station 1	Mitigation Through Design:	
	- selection and maintenance of mobile construction equipment for quiet operation.	p. 7-2
	- shut down equipment when not in active use	p. 7-2
	- conduct blasting so as to minimize noise and ground vibration levels.	p. 7-3
b) COMMUNITY REACTION		
Thompson-Bonaparte Confluence	Mitigation as above for residential land use.	

FORM M-2

MATRIX 5 FOR AREA C3 SHEET 1

PHASE OPERATION PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE: June 5, 1978

RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPT-ABLE LEVEL	MITIGATION AVOID	TIMING	DESIGN	COMPENSATION PRIVATE	PUBLIC	ENHANCE-MENT
a) RESIDENTIAL LAND USE									
Thompson-Bonaparte Confluence									
-Booster Pumping Station 1	LOW - MOD	6 Homes 16-18 People (R)	YDNL 55	✓		✓			
b) COMMUNITY REACTION									
Thompson-Bonaparte Confluence	MOD-EXT. (HIGH)	6 Homes 16-18 People.	Normalized YDNL 55	✓		✓			

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 5, AREA C3, PHASE OPERATION

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Thompson-Bonaparte Confluence		
-Booster Pumping Station 1	Mitigation through Avoidance: - locate Pumping Station further up-river away from residences.	
	Mitigation through Design:	
	- selection of quiet ventilation fans and/or silencing of fan intakes.	p. 7-9
	- selection of quiet roof top exhaust fans.	p. 7-9
	- erection of stub wall or screen on north side of transformer.	p. 7-9
b) COMMUNITY REACTION		
Thompson-Bonaparte Confluence		
-Booster Pumping Station 1	Mitigation as above for Residential Land Use.	

FORM M-2

MATRIX 6 FOR AREA C3 SHEET 1

PHASE DECOMMISSIONING PREPARED BY: HARFORD, KENNEDY WAKEFIELD LTD. DATE: June 5, 197

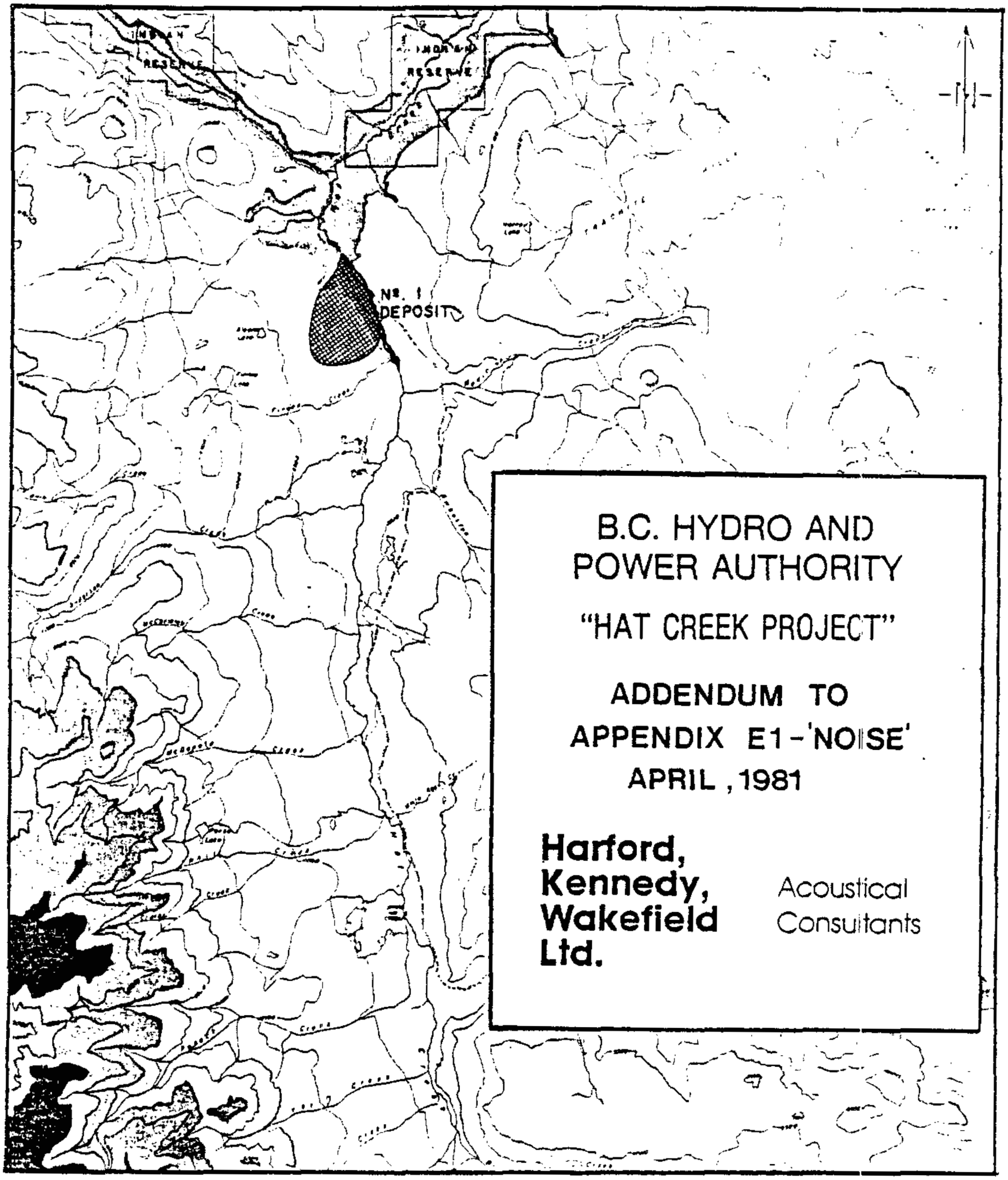
RESOURCE	IMPACT	AMOUNT AFFECTED	ACCEPTABLE LEVEL	MITIGATION			COMPENSATION		ENHANCEMENT
				AVOID	TIMING	DESIGN	PRIVATE	PUBLIC	
a) RESIDENTIAL LAND USE									
Thompson - Bonaparte Confluence									
-Booster Pumping Station 1	LOW-MOD	6 Homes 16-18 People (0)		✓		✓			

Harford, Kennedy, Wakefield Ltd

SUPPORTING INFORMATION FOR: SHEET 1

MATRIX M-2 - 6, AREA C3, PHASE DECOMMISSIONING

RESOURCE	COMMENTS	TEXT REFERENCES
a) RESIDENTIAL LAND USE		
Thompson-Bonaparte Confluence		
-Booster Pumping Station 1	Mitigation through Avoidance:	
	- Locate Pumping Station further up-river away from residences.	
	Mitigation through Design:	
	- selection and maintenance of mobile equipment for quiet operation	p. 7-2
	- shut down equipment when not in active use.	p. 7-2



B.C. HYDRO AND POWER AUTHORITY

"HAT CREEK PROJECT"

ADDENDUM TO APPENDIX E1 - 'NOISE'

APRIL, 1981

Harford, Kennedy, Wakefield Ltd.

Acoustical Consultants

REPORT 12-161-2

ADDENDUM TO APPENDIX E1-'NOISE'

Prepared For: B. C. Hydro and Power Authority,
555 West Hastings Street,
Vancouver, B. C.

Prepared By: Harford, Kennedy, Wakefield Ltd.,
1727 West 2nd Avenue,
Vancouver, B. C.

D. S. Kennedy, P. Eng.

Date: May 13, 1981

ERRATA TO AUGUST 1978 APPENDIX E1 - NOISE

Page 4-18, 8th line:	"designed" should be designated".
Page 4-46, 5th line:	"Drawing No. 6044-C14-E7" should be "Drawing No. 604H-C14-E7".
Page 6-38, 19th line:	"below 98 dBA" should be "below 77 dBA".
Page 6-44, 11th line:	Add "Once normal plant operation has commenced, traffic noise levels will be approximately 4 dBA lower than indicated in Figure 6-16".
Page 6-57, 5th line:	"Moderate" should be "High".

1.0 INTRODUCTION

The purpose of this report is to document additional noise studies pertaining to the proposed Hat Creek Project which have been undertaken since detailed environmental studies were completed in August, 1978. The additional studies were made necessary by recent changes in the proposed project as noted below:

1) Elimination of the North Valley Dump.
2) Relocation of the coal preparation facilities.
3) Relocation of access road in vicinity of the Bonaparte Indian Reserve.
4) Relocation of maintenance facilities.
5) Relocation of mine camp.
6) Revised mining production schedule.
7) Addition of a partial wet flue gas desulphurization (FGD) system.
8) Revised construction schedule for water supply system.

The acoustical implications of these changes are discussed in the following sections of this report. Predicted noise levels, taking these changes into account, are shown graphically in Figures 1 and 2 in terms of Yearly Day-Night Level (YDNL) contours.

2.0 NOISE LEVELS DURING FIRST YEAR OF PROJECT (PEAK CONSTRUCTION NOISE)

The construction schedule for the current mine description is presented in Appendix A. Although some preliminary work is indicated in Year -5 of this schedule, Year -4 is considered the first year of the project for the purpose of evaluating peak construction noise.

2.1 ELIMINATION OF NORTH VALLEY DUMP

According to the original project description, filling of the North Valley Dump was to be undertaken during the first year of the project.

2.1 ELIMINATION OF NORTH VALLEY DUMP (Continued)

This operation was expected to dominate the acoustic environment near the southwest corner of Bonaparte Indian Reserve No. 1. The current project description has eliminated this dump and as a result some reduction in noise levels will be realized in this area. The material which was to have been deposited in the North Valley Dump will instead be deposited in the Houth Meadows Waste Disposal Area. During the initial years of the project, this material will be transported by trucks or scrapers over the haul road indicated in Figure 1, and in subsequent years (commencing in Year -2) the trucks or scrapers will be replaced by a conveyor.

The noise contours surrounding the haul road in Figure 1 assume six vehicles working continuously for two shifts per day and seven days per week.

2.2 RELOCATION OF ACCESS ROAD, COAL PREPARATION FACILITES, MAINTENANCE FACILITES AND MINE CAMP

During Year -4, the southwest corner of Indian Reserve No. 1 will be exposed to noise resulting from construction of the access road, maintenance facilities and mine camp. Construction of the coal preparation facilities located approximately 1 km south of Indian Reserve No. 1, will not commence until Year -3.

Noise associated with construction of the access road approximately 0.3 km south of Indian Reserve No. 1 will predominate over noise from construction of the mine camp and maintenance facilities. Hence, it is the access road construction which will determine the noise levels in this area as indicated by the contours in Figure 1.

2.3 NOISE IMPACT ASSESSMENT

(a) Bonaparte Indian Reserve 1:
The maximum YDNL currently predicted at the Bonaparte Indian

2.3 NOISE IMPACT ASSESSMENT (Continued)

Reserve 1 is 62 dBA at the southwest corner of the Reserve. Although this value is unchanged from the earlier (August, 1978) prediction, noise levels are now expected to decrease more rapidly as one moves further into the Reserve. At the closest residence to the construction activity, the predicted YDNL is 56 dBA which is slightly above the criteria of YDNL 55 for residential land use compatibility.

The normalized YDNL's to be expected on Reserve 1 are obtained by adding the sensitivity correction of +10 dB to all project YDNL contours in Figure 1 which fall within the reserve boundaries. Therefore at the closest residence, the normalized YDNL will be 66 dBA which is categorized as a "moderate" noise impact as explained in the original Appendix E1-'Noise' prepared in August, 1978.

(b) Hat Creek Valley Ranches:
The trucks or scrapers used initially to haul material from the pit to Houth Meadows Disposal Area will produce YDNL 60 at the nearest ranch house (E. Lehman). At the next ranch (M. Saulte/I. Lehman), the YDNL will be approximately 51 and at the third ranch (A. Parke), a YDNL of about 36 is expected. At the E. Lehman ranch, the residential land use criteria (YDNL 55) will be exceeded and, since the normalized YDNL will be 75 at this location, the expected noise impact is categorized as "high". At the M. Saulte/I. Lehman ranch, the normalized YDNL will be 66 dBA which is categorized as a "moderate" noise impact. At the A. Parke ranch where the normalized YDNL will be 51 dBA and at ranches further south, no significant impact is predicted.

3.0 MAXIMUM PROJECT NOISE (FULL PLANT AND MINE OPERATION)

3.1 RELOCATION OF ACCESS ROAD, COAL PREPARATION FACILITIES AND MAINTENANCE FACILITIES

During normal operation of the plant and mine, noise from the access road, coal preparation facilities and maintenance facilities will be overshadowed by noise from the mine and mine mouth. Hence, the recent relocation of these facilites will not change the noise contours calculated previously for this area. Operating noise contours are shown in Figure 2.

3.2 REVISED MINING PRODUCTION SCHEDULE

Under the original mine production schedule developed by PD NCB Consultants Ltd., 27.9 x 10^6 bm^3/year of material was to be mined during Stage 6 and of this, 9.2 x 10^6 bm^3/year would be superficials. During the busiest 6 years of the current production schedule (years 8 to 13 inclusive), an average of 25.2 x 10^6 bm^3/year of material is to be mined of which 10.9 x 10^6 bm^3/year is superficials. Hence, there will be a reduction of approximately 10% in total material mined during the period of interest. However, relative to the old schedule, the amount of superficials mined under the current schedule is slightly higher. Since removal of superficials results in higher noise levels than excavation at lower levels of the pit, these two effects will tend to counteract each other such that there will be no net change in noise levels.

3.3 PARTIAL WET FLUE GAS DESULPHURIZATION SYSTEM

With the inclusion of a partial wet flue gas desulphurization (FGD) system, the following equipment and processes will be added to the original power plant design.

1) Truck delivery of reagent to the power plant.
2) Reagent preparation plant.
3) Electrically-driven FGD booster fans.
4) Sludge dewatering plant.

3.3 PARTIAL WET FGD SYSTEM (Continued)

Items (2) and (4) will comprise slowly rotating machinery and will be completely enclosed. Hence, noise emission will be insignificant relative to other sources.

Item (1), truck delivery of reagent, will increase noise levels along the access road between the assumed on site lime stone deposit (see Figure 3) and the power plant. The noise contours shown in Figure 2 take into account this additional truck traffic, assuming that one 20 ton truck passes a given point on the road every 10 minutes throughout one eight hour shift per day (weekdays only). This is the level of traffic required to supply the power plant with the 3.9 kg./sec. of reagent necessary during full operation (i.e. at 2000 MW). No significant noise impact will be experienced by local residents as a result of this trucking since other noise sources will predominate.

Item (3), FGD booster fans, would likely be added immediately upstream of the induced draft fans in order to compensate for the increased pressure drop that would result from the FGD system. The booster fans would be virtually the same as the induced draft fans but would be operating under a lower static pressure (15 "w.g. as opposed to 24.5" w.g.). Due to this lower static pressure, the sound power generated by the booster fans would be approximately 4 dB quieter than the induced draft fans. Combining the sound power generated by both booster and induced draft fans would result in a total sound power level approximately 1.5 dB higher than for induced draft fans alone. However, beyond the power plant fenceline, induced draft fan noise is not a predominant source and therefore this increase of 1.5 dB due to addition of booster fans would not change total noise levels except perhaps within the plant boundaries.

4.0 REVISED CONSTRUCTION SCHEDULE FOR WATER SUPPLY SYSTEM

The current construction schedule for the cooling water supply system is presented in Appendix B of this report. Since this schedule is more

4.0 REVISED CONSTRUCTION SCHEDULE FOR WATER SUPPLY SYSTEM (Continued)

detailed and up to date than the one used previously for noise prediction, construction noise levels for the water supply system have been reassessed. In general, this has not led to any significant changes in predicted noise levels. The one exception is that only 5 months will be required to construct the structures of booster stations 1 and 2, whereas 12 months was assumed originally.

For booster station 1, this will result in YDNL values 4 dB less than those given on page 6-17 of the August 1978 Appendix E1 - "Noise". This means that the present noise levels, which are already excessive for residential land use, will increase by 1 to 4 dB and not by 5 to 8 dB as previously calculated. The resultant YDNL values will vary from 65 to 53 and since the community sensitivity correction in this area is zero, the normalized YDNL will also range from 65 to 53. The corresponding noise impacts, considering both land use and annoyance criteria, are categorized as "moderate" at the closest locations and "insignificant" at more distant locations.

It was previously predicted that noise from the construction of booster station 2 would adversely affect 0.3 km^2 (0.12 $mi.^2$) of potential grazing land for one year. However, according to the more recent construction schedule, this construction noise would continue for only 5 months. Hence the YDNL criterion of 65 dBA for grazing land will be exceeded over a smaller area (approximately 0.12 km^2 or 0.05 $mi.^2$).

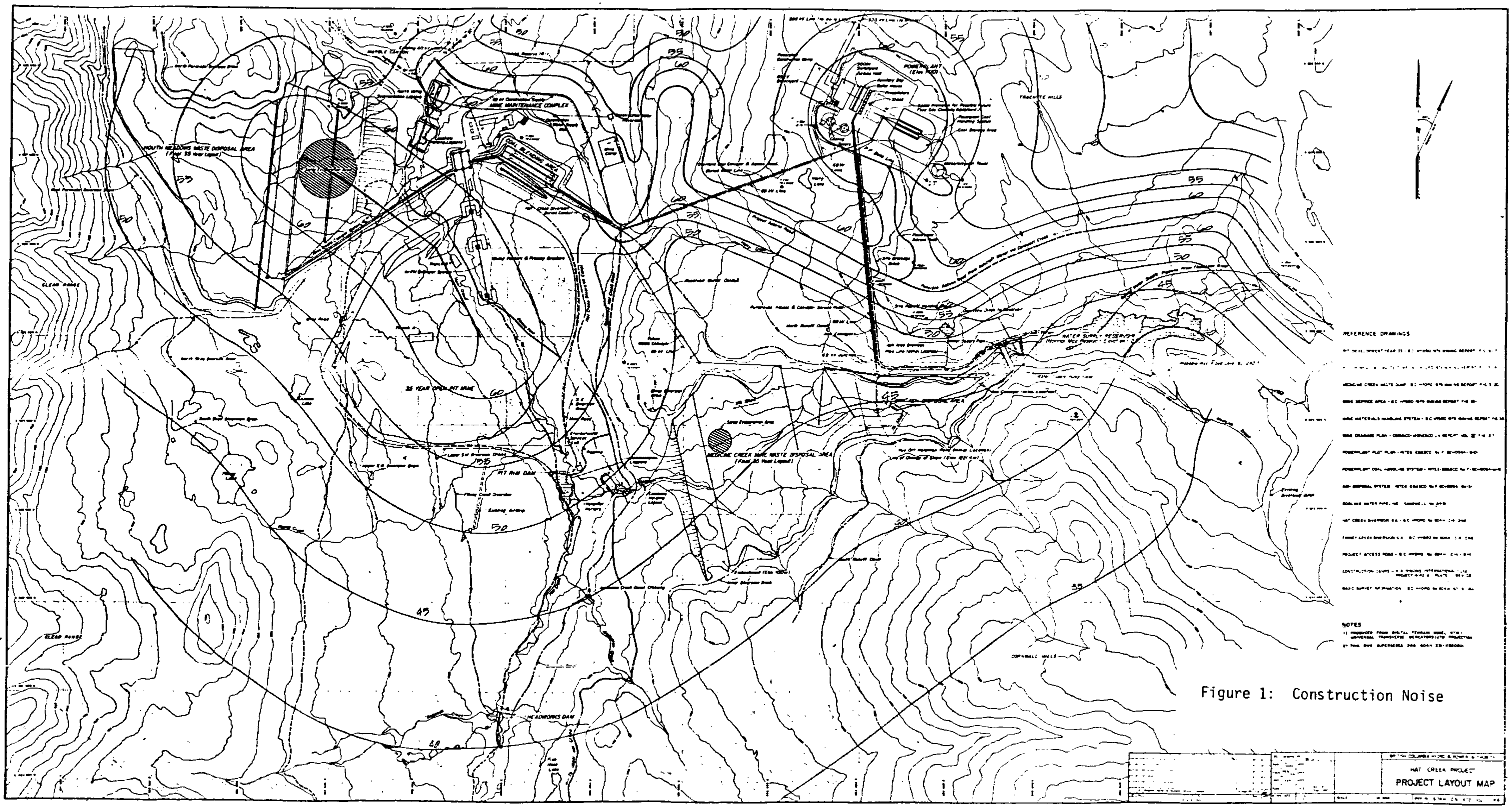


Figure 1: Construction Noise

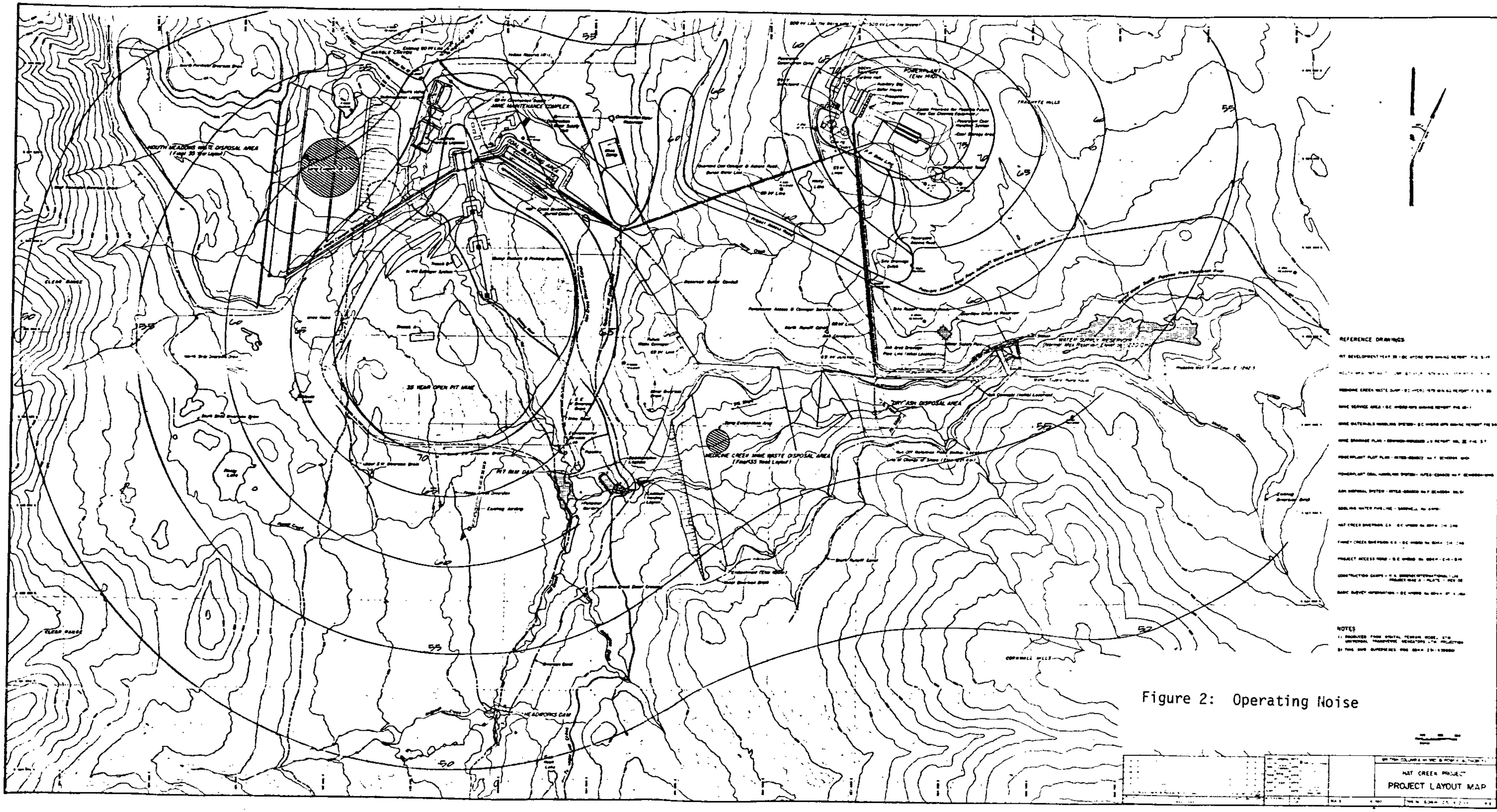


Figure 2: Operating Noise

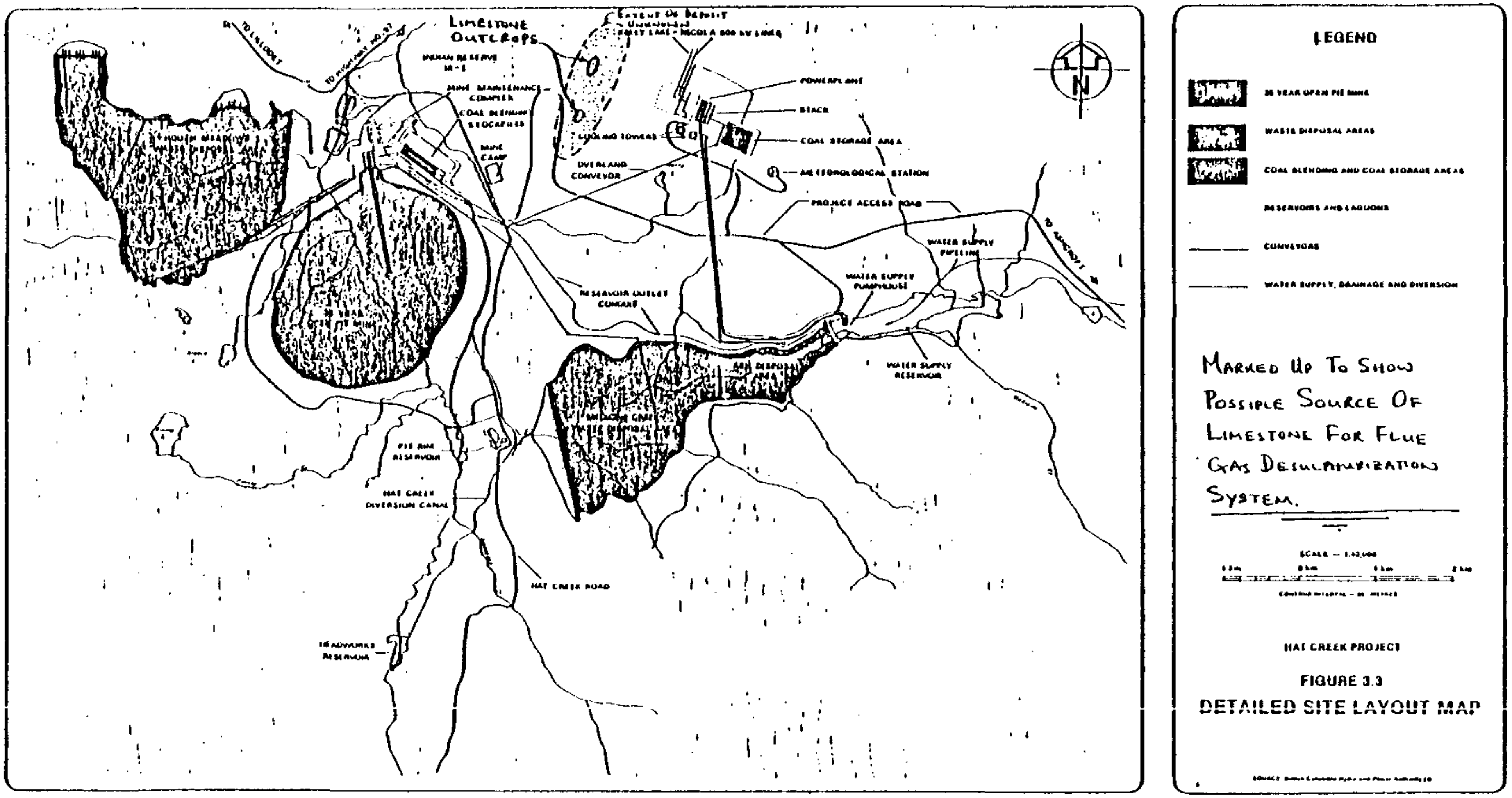
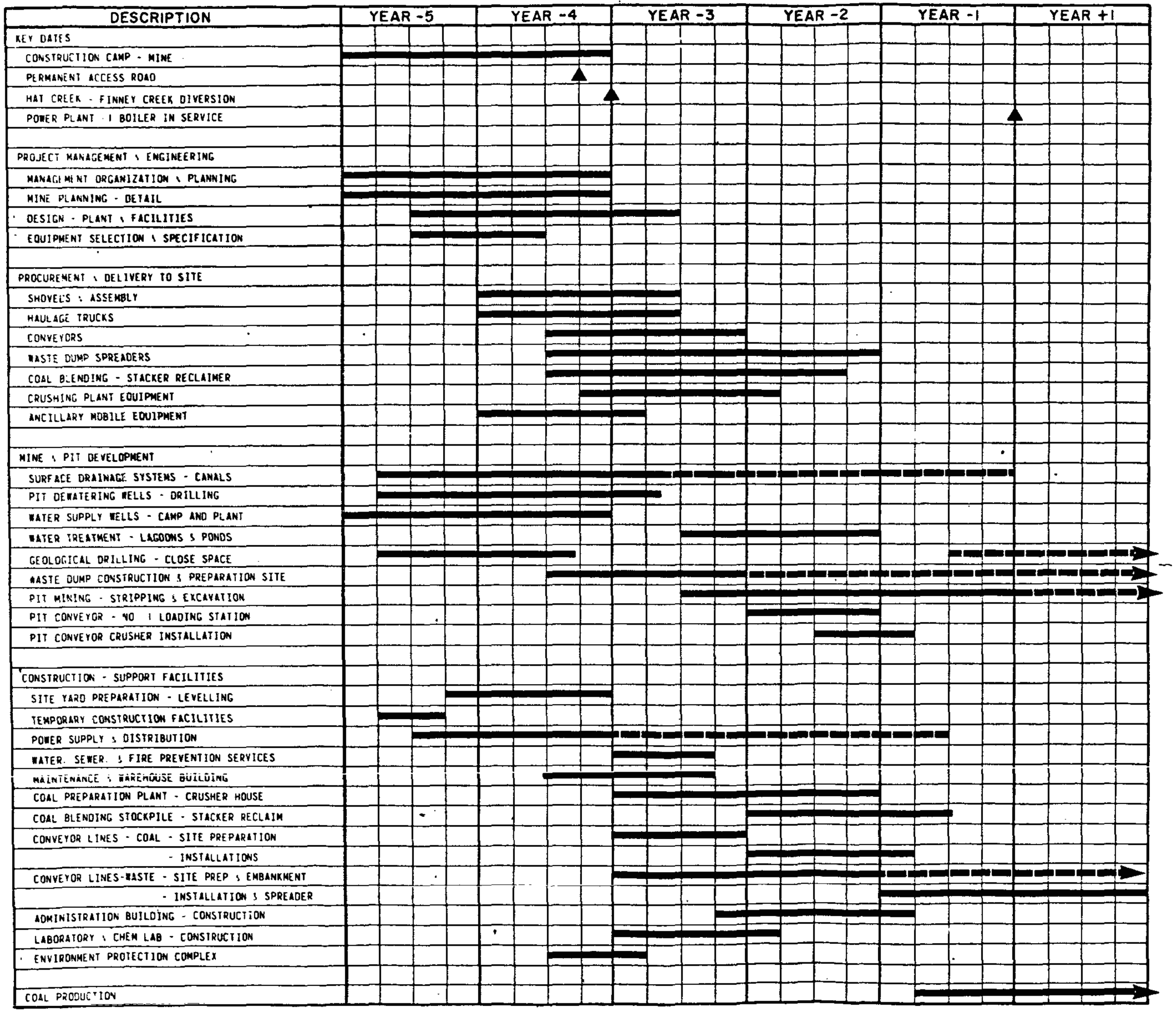


Figure 3: Location of On-Site Limestone Deposit

APPENDIX B

WATER SUPPLY CONSTRUCTION SCHEDULE



HAT CREEK PROJECT

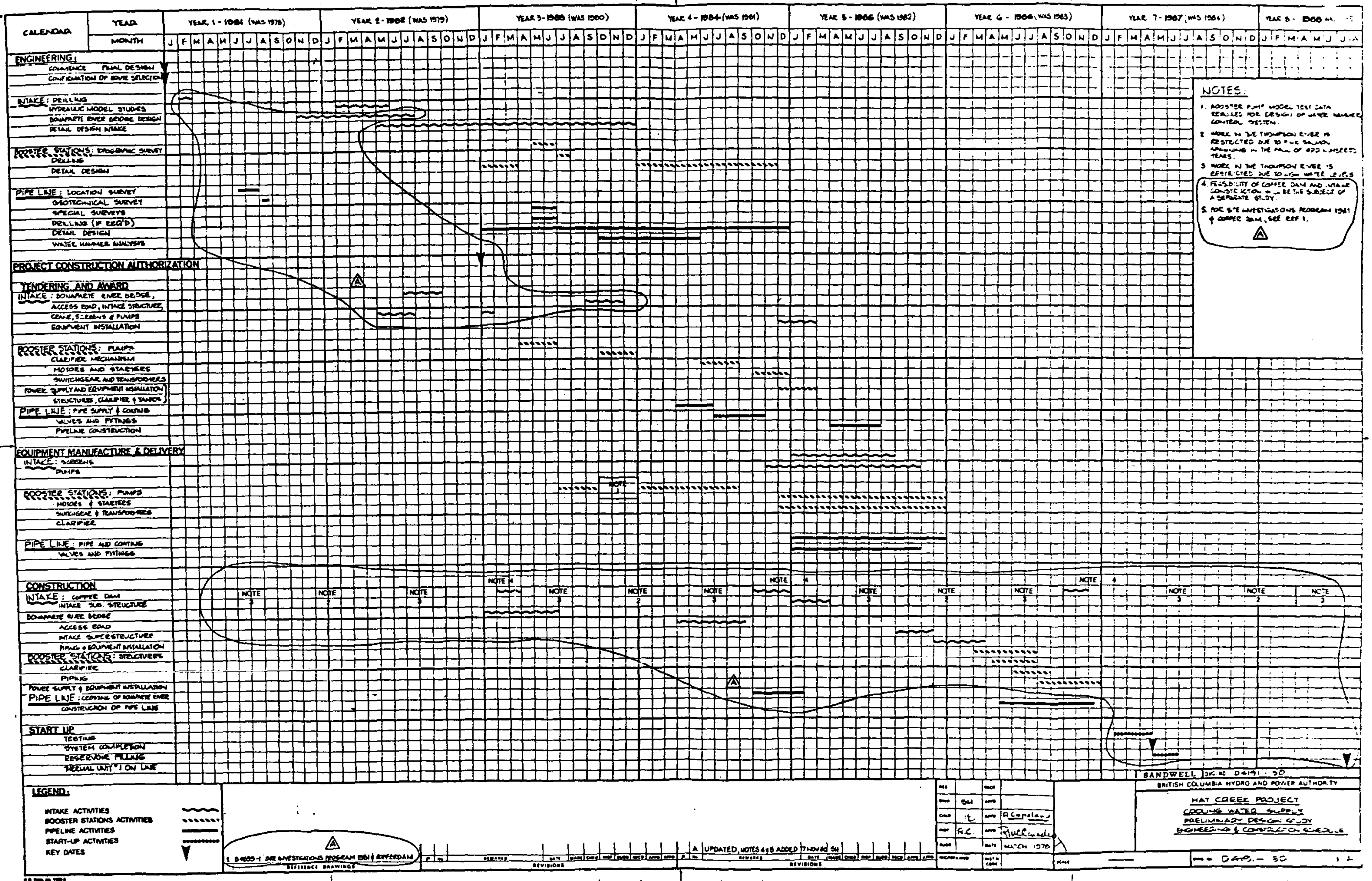
FIGURE 12-1

CONSTRUCTION SCHEDULE

SOURCE: British Columbia Hydro and Power Authority

APPENDIX A

MINE CONSTRUCTION SCHEDULE



CALENDAR
YEAR
MONTH
YEAR 1 - 1981 (WAS 1978)
YEAR 2 - 1982 (WAS 1979)
YEAR 3 - 1983 (WAS 1980)
YEAR 4 - 1984 (WAS 1981)
YEAR 5 - 1985 (WAS 1982)
YEAR 6 - 1986 (WAS 1983)
YEAR 7 - 1987 (WAS 1984)
J F M A M J J A S O N D
ENGINEERING:
COMMENCE FINAL DESIGN
CONFIRMATION OF ROUTE SELECTION
INTAKE: DRILLING
HYDRAULIC MODEL STUDIES
BONAPARTE RIVER BRIDGE DESIGN
DETAIL DESIGN INTAKE
BOOSTER STATIONS: TOPOGRAPHIC SURVEY
DRILLING
DETAIL DESIGN
PIPE LINE: LOCATION SURVEY
GEOTECHNICAL SURVEY
SPECIAL SURVEYS
DRILLING (IF REQ'D)
DETAIL DESIGN
WATER HAMMER ANALYSIS
PROJECT CONSTRUCTION AUTHORIZATION
TENDERING AND AWARD
INTAKE: BONAPARTE RIVER BRIDGE, ACCESS ROAD, INTAKE STRUCTURE, CRANE, SCREENS & PUMPS
EQUIPMENT INSTALLATION
BOOSTER STATIONS: PUMPS
CLARIFIER MECHANISM
MOTORS AND STARTERS
SWITCHGEAR AND TRANSFORMERS
POWER SUPPLY AND EQUIPMENT INSTALLATION
STRUCTURES, CLARIFIER & TANKS
PIPE LINE: PIPE SUPPLY & COATING
VALVES AND FITTINGS
PIPELINE CONSTRUCTION
EQUIPMENT MANUFACTURE & DELIVERY
INTAKE: SCREENS
PUMPS
BOOSTER STATIONS: PUMPS
MOTORS & STARTERS
SWITCHGEAR & TRANSFORMERS
CLARIFIER
PIPE LINE: PIPE AND COATING
VALVES AND FITTINGS
CONSTRUCTION
INTAKE: COFFER DAM
INTAKE SUB. STRUCTURE
BONAPARTE RIVER BRIDGE
ACCESS ROAD
INTAKE SUPERSTRUCTURE
PIPING & EQUIPMENT INSTALLATION
BOOSTER STATIONS: STRUCTURES
CLARIFIER
PIPING
POWER SUPPLY & EQUIPMENT INSTALLATION
PIPE LINE: CROSSING OF BONAPARTE RIVER
CONSTRUCTION OF PIPE LINE
START UP
TESTING
SYSTEM COMPLETION
RESERVOIR FILLING
THERMAL UNIT 1 ON LINE
NOTE 1
NOTE 2
NOTE 3
NOTE 4
NOTES:
1. BOOSTER PUMP MODEL TEST DATA REQUIRED FOR DESIGN OF WATER HAMMER CONTROL SYSTEM.
2. WORK IN THE THOMPSON RIVER IS RESTRICTED DUE TO PINK SALMON SPAWNING IN THE FALL OF ODD NUMBERED YEARS.
3. WORK IN THE THOMPSON RIVER IS RESTRICTED DUE TO HIGH WATER LEVELS
4. FEASIBILITY OF COFFER DAM AND INTAKE CONSTRUCTION WILL BE THE SUBJECT OF A SEPARATE STUDY.
5. FOR SITE INVESTIGATIONS PROGRAM 1981 & COFFER DAM, SEE REF 1.
LEGEND:
INTAKE ACTIVITIES
BOOSTER STATIONS ACTIVITIES
PIPELINE ACTIVITIES
START-UP ACTIVITIES
KEY DATES
1 D4803-1 SITE INVESTIGATIONS PROGRAM 1981 & COFFERDAM
REFERENCE DRAWINGS
REVISIONS
A UPDATED, NOTES 4 & 5 ADDED 7 NOV 80 SH
REVISIONS
SH
A Copeland
R.C.
MARCH 1978
BANDWELL
D4191 - 30
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
COOLING WATER SUPPLY
PRELIMINARY DESIGN STUDY
ENGINEERING & CONSTRUCTION SCHEDULE
D4191 - 30