



LIBRARIES

UNIVERSITY OF WISCONSIN-MADISON

[Crandon Mine Project environmental assessment report]. 1985?

[Place of publication not identified]: [publisher not identified], 1985?

<https://digital.library.wisc.edu/1711.dl/JNXJUT42L6GQA8J>

<http://rightsstatements.org/vocab/InC/1.0/>

For information on re-use see:

<http://digital.library.wisc.edu/1711.dl/Copyright>

The libraries provide public access to a wide range of material, including online exhibits, digitized collections, archival finding aids, our catalog, online articles, and a growing range of materials in many media.

When possible, we provide rights information in catalog records, finding aids, and other metadata that accompanies collections or items. However, it is always the user's obligation to evaluate copyright and rights issues in light of their own use.

TD
194.66
W62
C708
no. 20

1.8.7 Blasting and Seismic Vibrations Monitoring

Conditions

1. Blasting During Shaft Sinking

The first phase of the operation at the mine is the sinking of various operating shafts and accessways to the mine. The upper part of this work is through glacial overburden soil, above and below the groundwater table. In order to perform this work at minimum expense, it is proposed to freeze the overburden soils to provide support for the adjacent earth. The excavation through this overburden soil will be mainly by earth excavation equipment, but it may be facilitated by use of explosive charges.

After the shafts and other accessways reach bedrock, it will be necessary to use drilling and blasting techniques to loosen the material for excavation. The upper part of the excavation, in the weathered rock, will require less explosives than deeper fresh rock.

a. Main Shaft and Intake Air Shaft

This work in bedrock will require two bench blasts per day for the Main Shaft and 2.5 blasts per day for the smaller Intake Air Shaft.

b. East and West Exhaust Ventilation Shafts

These shafts are the largest, from 21 m deep to the 230 m level. After drilling of a 6.7 m (22-foot) diameter relief

hole, the shafts will be enlarged by drilling and blasting, from the top down.

2. Blasting During Production Operations in the Mine

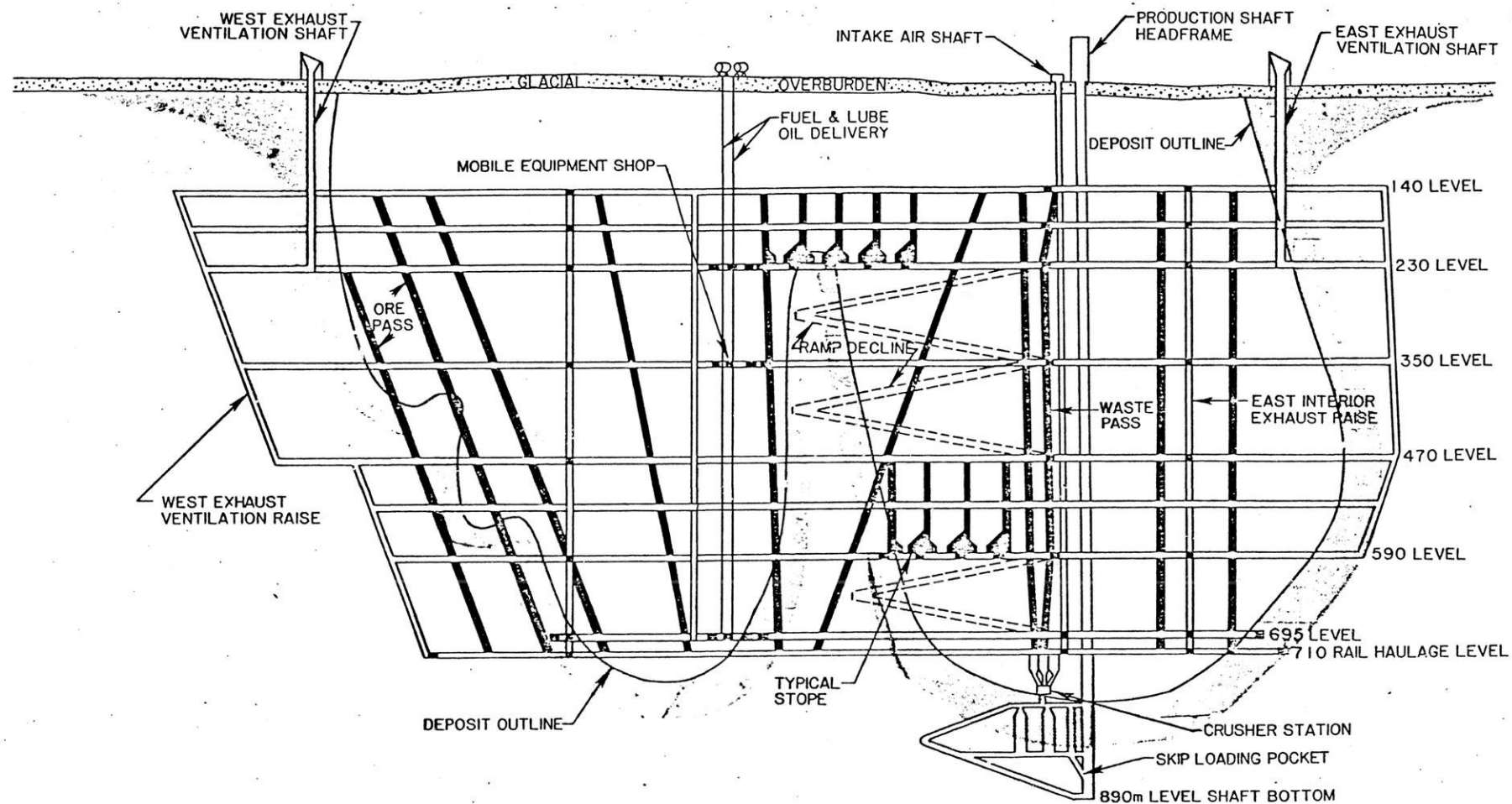
This is the main area of work where explosives will be utilized through a longer period of time than for mine access work. The charges of explosives are required to loosen the ore and the rock in the proximity of the ore body. Numerous rises and accessways are proposed (see Figure 1-1). The largest individual blasts will occur in the lower part of the ore body between the 140 and 290 m levels.

Experimental Plan

Production blast monitoring is planned to optimize the level of blasting in order to minimize the external effects. The current plan is to monitor the closely located EXXON-owned structures for vibration levels. This will provide site-specific data for use in the analytical models and in predicting effects of different, possibly higher levels of explosive uses in the mine operations.

Since a level of 2.0 inches per second is being set for maximum vibration levels at close-by structures, blasting charges will thus be limited to avoid on-site building damages. This will automatically provide much less than the 2.0 inch per second vibration level at more distant structures.

There is no plan to conduct "test shots" ahead of production to establish whether or not production blasting predictions are correct, since production blasting can be modified during the work.



-NOT TO SCALE-

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE			
UNDERGROUND MINE LONGITUDINAL SECTION SCHEMATIC			
SCALE	NONE	STATE	WISCONSIN
COUNTY	FOREST		
DRAWN BY	D.R. SPRINGBORN	DATE	9/82
CHECKED BY	J.E. GRIMES	DATE	10/24/82
APPROVED BY	D.R. Mc	DATE	10/24/82
APPROVED BY	C.E. Fowler	DATE	10/24/82
DRAWING NO.	Figure 1 - 1		REVISION NO.
SHEET	1	OF	1
DATE	0		

Proposed Monitoring Plan

Site monitoring will be limited to close by building locations during the initial construction and operation events. The instruments will indicate peak particle velocity, which is the usual parameter used for this purpose. No preconstruction, preproduction, or on-going vibration monitoring is planned.

It is planned to examine all permanent structures within approximately one-half-mile from the closest planned blast (see Figure 1-2). The inspections will be done just prior to the start of the site blasting with allowance for State agency review prior to actual blasting. These items will be included in the inspections:

Foundations, concrete slabs, exterior and interior masonry, structural framing, exterior and interior wall treatments, ceiling and floor treatments, windows and doors (framing and glass), visible plumbing, exterior utility services, exterior structures (antennas, flag poles, etc.), miscellaneous elements as required.

Inspected elements will be fully documented including photographs that will be developed immediately. The inspections will be performed by State-licensed professionals. All inspections of private property will be with the owner's consent. Copies of preblasting survey inspection sheets will be submitted to each private owner and State agencies.

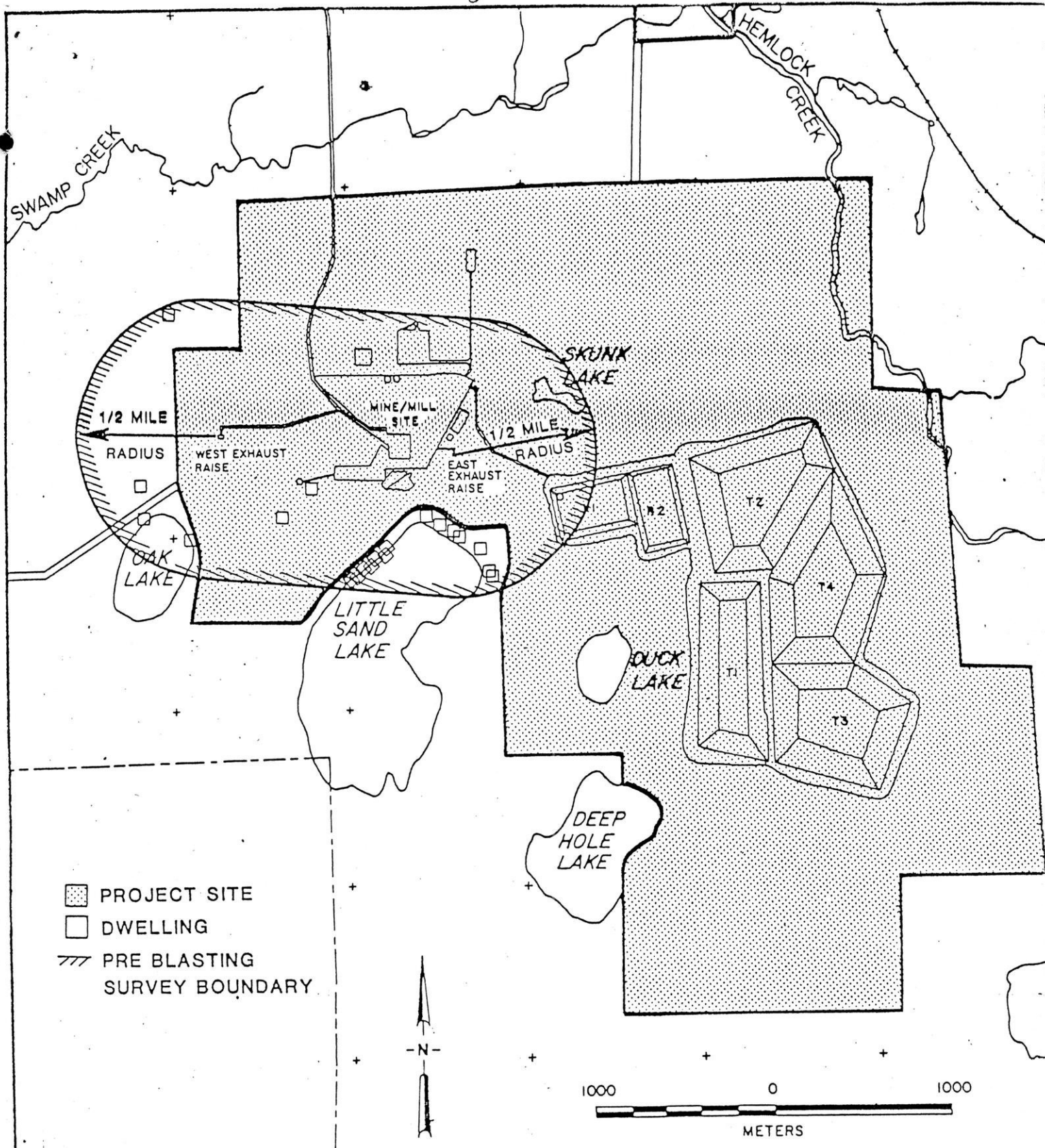


Figure 1 - 2
PRE BLASTING SURVEY BOUNDARY

CHAPTER 2 - DESCRIPTION OF THE AFFECTED ENVIRONMENT

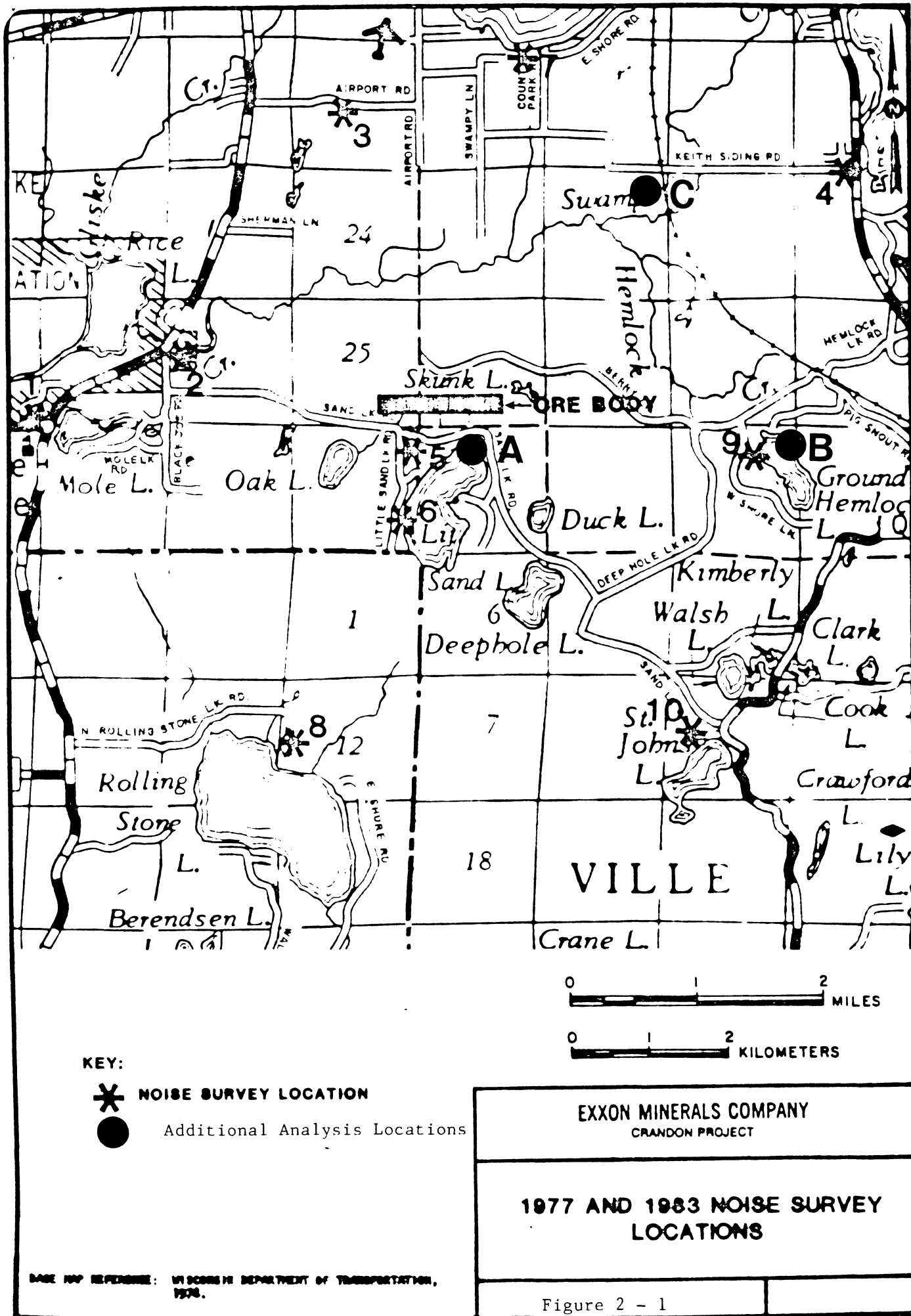
2.1.3 Noise and Vibrations in the Project Area

2.1.3.1 Noise in the Project Area

The existing background ambient noise levels for the project area were monitored during both the summer (July) and the winter (March) seasons in 1977 and 1983. Variations in noise levels resulting from seasonal changes (with and without foliage) were considered in the analysis. Sound levels were recorded throughout a 24-hour day, during daytime (0700-1800), evening (1800-2200) and nighttime (2200-0700) periods. During 1977, six sites were monitored for baseline data, and in 1983, four additional sites were tested. These sites included homes and recreational areas that could conceivably be impacted by construction, exploration and operational noise (see Figure 2-1 for a location of these sites).

The noise levels were recorded at each of the ten sites at three different times of the day, both winter and summer, for a period of time ranging from 16 to 21 minutes. This procedure is standard and allows for the development of 24-hour L_{dn} noise levels when the noise sources in the area are typical of what can be expected to occur on a daily basis. The seasonal monitoring accounts for variations in noise levels due to changes in foliage and local activities.

During winter, sources of sound at the locations monitored were from natural occurrences such as water flowing over a small dam, wind, branches rustling, dogs barking, birds and voices. Noise generated by other sources was attributed to chain saws, snowmobiles, traffic, aircraft, and gunshots. During the summer, sources of sound were mainly from human activities associated with a picnic area and campground, wind and leaves, birds, insects, voices, aircraft and traffic. At all locations, summer sound



levels were higher than those reported during the winter mainly because of increased human activity during measurement periods.

Daytime sound levels (L_d), nighttime sound levels (L_n) and day-night sound levels (L_{dn}) monitored at all locations in 1977 and 1983 for winter and summer are shown in Table 2-1. Refer to Exxon Minerals Company, Crandon Project - Environmental Impact Report, December 1982 (Revised July 1984), Appendix 2.8A and 2.8B, for complete ambient sound level and meteorological data taken during 1977 and 1983 field monitoring.

Table 2-1

Daytime, Nighttime and Day-Night Equivalent Sound Levels (dBA)

<u>Location</u>	<u>Winter</u>			<u>Summer</u>		
	<u>Ld</u>	<u>Ln</u>	<u>Ldn</u>	<u>Ld</u>	<u>Ln</u>	<u>Ldn</u>
1) School	43	30	42	47	43	50
2) Community Center	38	29	38	42	40	47
3) Mihalko Residence	39	24	38	44*	44	50*
4) Residence 3712	43*	35	44*	64	47	62
5) Exxon Field Office	42	38*	45	57*	27	55*
6) Webb Residence	42*	20	40*	38	39	45
7) Lake Metonga	45	42	49	48	41	49
8) Rolling Stone Lake	34	31	38	41	40	47
9) Ground Hemlock Lake	33	30	37	43	27	42
10) St. John's Lake	33	31	38	39	28	39

 *Values were adjusted to reduce the contribution from short duration, high sound pressure level sources. The procedure for calculating L_d , L_n and L_{dn} is described in Appendix A.

In addition to the ten monitored noise sensitive areas previously discussed, three specific residences were assessed around the north side of Little Sand Lake, the east side of Ground Hemlock Lake, and near the intersection of the Soo Line Railroad and Keith Siding Road. The location of these sites are also shown in Figure 2-1. The sound levels at the three sites are presented in Table 2-2.

Table 2-2
Summary of Equivalent Sound Levels (dBA)
at Three Additional Baseline Locations

<u>Location</u>	<u>Winter</u>			<u>Summer</u>		
	<u>Ld</u>	<u>Ln</u>	<u>Ldn</u>	<u>Ld</u>	<u>Ln</u>	<u>Ldn</u>
A) North Shore, Little Sand Lake	42*	20	40*	38	39	45
B) East Shore, Ground Hemlock Lake	33	30	37	43	27	42
C) Keith Siding Road, Just West of Soo Line Railroad	43	39	46	46	43	50

*Values were adjusted to reduce the contribution from short duration, high sound pressure level sources. The procedure for calculating L_d , L_n and L_{dn} is described in Appendix A.

Ambient winter and summer sound levels at these locations are expected to be in the same range as those recorded at the ten locations sampled. As presented below, values were estimated for each of the three locations by using measured values from other locations where land use was similar.

1. Location A, North Shore of Little Sand Lake - Ambient sound levels at this location should be similar to those recorded at Location 6, the Webb residence on Little Sand Lake Road.
2. Location B, East Shore of Ground Hemlock Lake - Ambient sound levels at this location should be similar to those recorded at Location 9, the west shore of Ground Hemlock Lake.
3. Location C, Residence West of the Soo Line Near the Intersection with Keith Siding Road - Ambient sound levels at this location should be similar to those recorded at Locations 3 (Mihalko residence on Airport Road) or 7 (south shore of Lake

Metonga in the parking lot of Forest County Veterans Memorial Park).

With the exception of summer activities at the Forest County Veterans Memorial Park, sound sources at Location C should be similar to those at Locations 3 and 7. However, Location C is approximately 1,265 feet from the Soo Line and 800 feet from the Keith Siding Road which contribute to the acoustical environment. Therefore, ambient sound levels at Location C were determined by logarithmically averaging L_d and L_n sound levels from Locations 3 and 7 and then logarithmically summing the L_d and L_n to get the L_{dn} .

The results of monitoring showed that the ambient sound levels in the project area are comparable to those found in a rural or quiet suburban neighborhood (National Academy of Sciences, 1977). The Environmental Protection Agency (EPA) has identified a day-night sound level (L_{dn}) of 65 dBA as its short-term goal and an L_{dn} of 55 dBA as its long-term goal. EPA has identified its long-term goal as a requisite for the protection of public health and welfare (EPA, 1974). Day-night sound levels at all 13 locations monitored were below the EPA's short-term goal (65 dBA L_{dn}). All locations except Site 4 (Residence 3712) were at or below EPA's long-term goal (55 dBA L_{dn}). The methodology used in determining the ambient noise level is presented in Appendix A.

2.1.3.2 Vibrations in the Project Area

General Discussion

The area of the project is sparsely populated rural; generally non-agricultural and heavily wooded. Lakes are used for fishing and other recreation. Seismic vibrations that would occur in the area are limited to automobile and truck traffic on local roads. There are no major highways in the area carrying heavy traffic.

On-Site Affected Environment

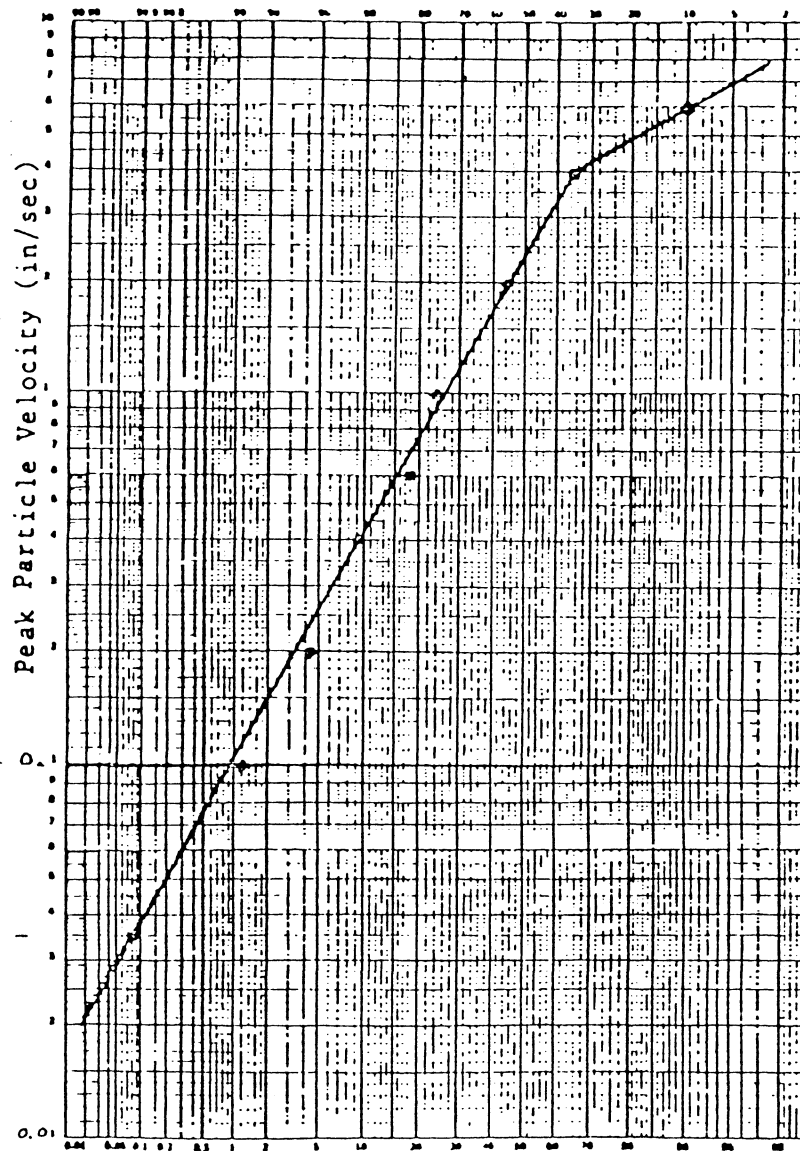
This area will be changed from a generally wooded area to one of an industrial nature. The existing environment is quiet, with no seismic generators, other than traffic on the roads in the area.

Off-Site Affected Environment

The rural area off-site (which may be influenced by the project) is mostly sparsely populated and heavily wooded. The area near Little Sand Lake and similar lakes has residential buildings, cottages and similar structures, used for residential and recreational purposes. The seismic generators on and near this area are currently limited to automobile and truck traffic on the roadways. Generally, little seismic vibration is generated by the traffic, since traffic is light and infrequent. For the most part, no seismic vibrations noticeable to the human body occur in this area.

The chart in Figure 2-2 would indicate that a velocity of 0.01 to 0.1 inches per second to be the lower limit of human response to seismic vibrations. It should be noted that a typical residence will vibrate locally (one room) under the impact of heavy walking, at levels from 0.2 inches per second and less. This form and level of seismic vibration is considered tolerable by most people. It is the most common "seismic" type of vibration that humans in the area might be exposed to. Traffic seismic vibrations are less common.

The seismic vibrations that are induced into a structure from truck traffic on nearby roads is influenced by the distance from the traffic and the condition of the roads. For the usual rural set-back distances from roadways, the level of seismic vibration that is produced is usually less than the lower limit of human response.

CRANDON BLASTING VIBRATION ESTIMATEGENERAL HUMAN & STRUCTURAL RESPONSE TO PEAK PARTICLE VELOCITY LEVELSHUMAN RESPONSE*PROBABILITY OF NO COMPLAINTS*COMMENTS**UnbearableIn sufferableVery UnpleasantUnpleasantDisturbingDefinitely DetectableDetectableBarely DetectableCan Be DetectedDetection LimitPROBABILITY OF COMPLAINTS*Concrete Block Foundations May SplitMinor Falls of Plaster; Heavy Cracking of PlasterMinor Cracking of PlasterSafe Blasting Criterion For Residential Structures. Recommended by U.S. Bureau of MinesRigidly Mounted Mercury Switches Trip OutThreshold of Advising Population of Blast Structure Surveys Conducted

*VIBRA-TECH (1976) COMPILED FROM USBM DAT

**CANMET (1977)

Generally, current seismic vibration generators do not create vibrations that exceed the level of human response within approximately 100 to 200 feet of a roadway. For this reason, the area is considered relatively free from seismic vibrations.

CHAPTER 3 - ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

3.1.3 Noise and Vibration Impacts

3.1.3.1 Noise Impacts

Noise-sensitive locations near the project area and their respective ambient noise levels have been identified in Chapter 2. Baseline sound level measurements were monitored at six locations in 1977 and at four sites in 1983 during the winter and summer periods. Three additional sites, all residences, were further evaluated based on the data obtained at the ten monitoring sites. The locations monitored and the distance from the projected noise source are listed in Table 3-1.

The International Organization for Standards (1971) has adopted guidelines for assessing community response to noise based upon the change the community will experience by a change in ambient sound. This table is abstracted below:

<u>Difference, dB</u>	<u>Category</u>	<u>Description</u>
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very Strong	Vigorous community action

Construction Impacts

Construction activities would occur in several phases: site clearing; grading and excavation; equipment erection; facility fabrication; and finish work and landscaping. The excavation phase is expected to be the noisiest activity during the construction phase.

TABLE 3-1

APPROXIMATE DISTANCES FROM NOISE SOURCES TO NOISE SENSITIVE AREAS

LOCATION	DESCRIPTION	MINE/MILL DISTANCE (ft)	MWDF DISTANCE (ft)	ACCESS ROAD DISTANCE (ft)	RAILROAD SPUR DISTANCE (ft)	HAUL ROAD DISTANCE (ft)	Tailings Transport	WATER DISCHARGE STRUCTURE DISTANCE (ft)	EXHAUST FAN WER DISTANCE (ft)	EXHAUST FAN EER DISTANCE (ft)
							PIPELINE DISTANCE (ft)			
1	Mole Lake School	16,700	20,000	15,700	22,800	19,800	19,800	9,300	13,600	18,000
2	Community Center	11,100	15,000	10,000	16,600	14,400	14,400	15,500	8,600	12,800
3	Mihalko Residence	11,600	15,000	3,000	11,800	13,800	13,800	27,000	12,600	14,000
4	Residence 3712	19,200	13,200	18,000	12,900	17,000	17,000	44,900	22,500	19,300
5	Exxon Field Office	2,900	4,800	2,200	9,200	4,900	4,900	24,900	1,750	2,750
6	Webb Residence	6,150	5,900	5,500	11,900	6,900	6,900	24,000	4,500	5,000
7	Lake Metonga, South Shore	13,700	15,200	7,100	10,000	14,200	14,200	35,500	16,000	15,500
8	Rolling Stone Lake, North Shore	17,600	15,500	16,900	23,300	18,300	18,300	23,400	15,100	16,300
9	Ground Hemlock Lake, West Shore	13,800	3,900	14,500	10,600	10,500	10,500	39,100	16,400	12,000
10	St. John's Lake	17,700	7,000	12,000	21,700	15,500	15,500	39,000	19,500	16,000

To estimate future (L_{eq}) noise levels and their expected impacts, the sound power level spectrum for the construction equipment is used to weight the sounds from a combination of sources in the project area.

The locations of construction activities were generalized to present a worst case situation. The first shaft for the mine/mill is located west of the access road while the other shaft is adjacent to the timber and steel storage areas. The mine waste disposal facility was assumed to be located at six locations with one-sixth of the sound power for the equipment at each location. The access road equipment was assumed to be located at four locations along the access road. Construction of the railroad spur would occur at the northeastern end of the railroad spur. The haul road and tailings transport pipeline would be located halfway between the mine/mill and mine waste disposal facilities. The water discharge pipeline would be constructed south of Mole Lake, about 2,200 feet from Location 1. Construction activities for the water discharge structure would occur at the discharge location on Swamp Creek, approximately 1.0 mile downstream from CTH M. A detailed methodology to calculate the construction period L_{eq} is discussed in Appendix A, along with the sound power level spectrum for all construction equipment.

Estimated noise levels from daytime and nighttime construction activities at the ten monitoring sites, Locations A-C and at other undefined locations in the environmental study area are presented in Figures 3-1 and 3-2. These figures illustrate the property boundary site and area with isopleths of A-weighted equivalent (L_{eq}) sound pressure levels. Existing (ambient) noise levels are not included in these figures. Daytime construction noise was based upon the "worst-case" assumption that construction activities will occur simultaneously at the mine/mill site locations, MWDF area, access road, railroad spur, haul road, tailings transport and water discharge pipelines, and the water discharge structures location. Nighttime construction noise was based only on

the simultaneous construction activity at the two shaft locations in the mine/mill site but no other equipment noise sources. Sound levels during construction activities at Locations A-C can be determined from Figures 3-1 and 3-2 and the background ambient sound levels in Chapter 2.1.3.1.

The noise levels for construction impacts were based on the type and quantity of equipment needed to complete a specific job. Mine waste disposal facility excavation equipment, associated sound levels, and usage factors (the time the equipment operates in its noisiest mode) are presented in Table 3-2. Equipment used for the tailings transport and water discharge pipeline, the railroad spur, and construction of the access road and haul road is listed in Table 3-3. The A-weighted sound pressure levels and usage factors are consistent with the source sound power level spectrums presented in the Appendix.

The total impact of construction (worst-case) activities is shown in Table 3-4. During winter, change in daytime ambient sound level, L_d , and day-night sound level, L_{dn} , would occur at almost all locations.

Mine/mill construction would involve a phase in which activity would occur for a 24-hour period during winter. This activity would significantly increase nighttime sound levels at Locations 5 and 6 and moderately at Locations 2 and 3 (see Table 3-4).

Residents living in the vicinity of Location 6 would experience a 13 dB change during the winter nighttime while residents near Location 9 would experience a 10 dB change during winter daytime. All other residents of noise-sensitive areas would experience less than or equal to a 6 dB change during daytime or nighttime periods. L_{dn} noise levels increase by 7 dB at Location 6 and by 6 dB or less at all other locations.

TABLE 3-2

WASTE DISPOSAL AREA EXCAVATION EQUIPMENT SOUND LEVELS

EQUIPMENT		MAXIMUM SOUND LEVEL L _A AT 15 M (50 FEET) (dB)	USAGE FACTOR
Scraper	CAT 631	87	0.13
Bulldozer	CAT D9	89	0.15
Bulldozer	CAT D8	89	0.15
Bulldozer	CAT D6	88	0.15
Front-End Loader	CAT 988	86	0.30
Front-End Loader	CAT 966	89	0.30
Motor Grader	CAT 16G	86	0.30
Motor Grader	CAT 14G	80	0.30
Excavator	CAT 235	83	0.70
Backhoe	J.D. 410	82	0.15
Dump Truck	Ford LT-9000	92	0.50
Belly Dump Truck and Trailer	Ford LT-9000	92	0.50

Total equivalent sound level (L_{eq}) contribution at 15 m (50 feet) = 93 dB

Source: Kessler, 1978

TABLE 3-3

CONSTRUCTION EQUIPMENT SOUND LEVELS

EQUIPMENT TYPE	QUANTITY	SOUND LEVEL dB AT 15 M	USAGE FACTOR
SLURRY AND WATER DISCHARGE PIPELINES AREA			
Bulldozer D7	1	88	0.15
Backhoe CAT 235	1	83	0.15
Front-End Loader 988B	1	86	0.15
Dump Truck 5 CYD	1	92	0.10
Flatbed Truck 8 T	1	83	0.10
Trencher	1	85	0.70

L_{eq} for site = 88 dB at 15 m

RAILROAD SPUR AREA			
Chainsaw	5	91	0.20
Front-End Loader 988B	1	86	0.15
Front-End Loader 992C	1	89	0.15
Bulldozer D9	1	89	0.15
Bulldozer D6	2	88	0.15
Backhoe (Comb.)	2	83	0.10
Motor Grader 16G	1	86	0.10
Dump Truck 5 CYD	8	92	0.10
Compactor	4	80	0.10

L_{eq} for site = 95 dB at 15 m

ACCESS ROAD AND HAUL ROAD AREA			
Chainsaw	5	91	0.20
Front-End Loader 988B	1	86	0.15
Front-End Loader 977L	1	89	0.15
Motor Grader 16G	2	86	0.10
Gradall G1200	1	86	0.10
Bulldozer D9	1	89	0.15
Bulldozer D6	2	88	0.15
Backhoe (Comb.)	2	83	0.10
Dump Truck 5 CYD	12	92	0.10
Compactor	5	80	0.10
Crane	2	85	0.05

L_{eq} for site = 96 dB at 15 m

Source: Sadik, 1983.

TABLE 3-4
CONSTRUCTION PHASE EFFECT ON AMBIENT SOUND LEVELS

Location	Baseline, dBA			Construction Noise, dBA		Total Noise During Construction dBA ¹⁾			Change, dB		
	Ld	Ln	Ldn	LA Day	LN Night ²⁾	Ld	Ln	Ldn	Ld	Ln	Ldn
Winter											
1	43	30	42	31	20	43	30	42	0	0	0
2	38	29	38	36	27	40	31	40	2	2	2
3	39	24	38	43	26	45	28	43	6	4	5
4	43 ³⁾	35	44 ³⁾	37	18	44	35	44	1	0	0
5	42	38 ³⁾	45 ³⁾	46	41	48	43	51	6	5	6
6	42 ³⁾	20	40 ³⁾	47	33	48	33	47	6	13	7
7	45	42	49	37	23	46	42	49	1	0	0
8	34	31	38	33	22	37	32	40	3	1	2
9	33	30	37	42	24	43	31	42	10	1	5
10	33	31	38	30	19	35	31	38	2	0	0
Summer											
1	47	43	50	31	20	47	43	50	0	0	0
2	42	40	47	36	27	43	40	47	1	0	0
3	44 ³⁾	44	50 ³⁾	43	26	47	44	51	3	0	1
4	64	47	62	37	18	64	47	62	0	0	0
5	57 ³⁾	27	55 ³⁾	46	41	57	41	56	0	14	1
6	38	39	45	47	33	48	40	49	10	1	4
7	48	41	49	37	23	48	41	49	0	0	0
8	41	40	47	33	22	42	40	47	1	0	0
9	43	27	42	42	24	46	29	44	3	2	2
10	39	28	39	30	19	40	29	40	1	1	1

1) Ambient plus construction phase noise.

2) Nighttime mine/mill contribution during shaft sinking.

3) Measured ambient values were adjusted to reduce the contribution from short duration, high sound pressure level sources.

Residents near Location 5 would experience a 14 dB increase during summer nighttime periods while residents near Location 6 would experience a 10 dB increase in summer daytime noise levels. All other locations would increase by 3 dB or less. L_{dn} noise levels during the summer would increase by up to 4 dB at all locations.

During construction, ambient sound levels would meet EPA's short-term and long-term goals at all locations, except the summer L_{dn} for Location 4, which would not meet the long-term goal (see Table 3-4). However, based on the difference in noise levels presented earlier, an increase in the noise levels of 10 dB or more could result in complaints or community action.

At some locations in the study area, the acoustical environment would substantially change as a result of construction activity, although these changes would be limited in duration. The majority of noise levels would not exceed the EPA guidelines, however ambient noise levels would increase at some locations and under certain meteorological conditions noise from construction activities could travel greater or lesser distances than those that were calculated. Extreme cases of solar heating, inversions, and tunnelling of acoustic energy caused by meteorological phenomena and the rolling topography of the area can cause short-term noise levels (15-30 minutes in duration) to be 10 to 20 dB greater or lessor than those presented.

Another concern is that the human ear responds slightly different than electronic devices. The human ear, even though exposed to construction noises created by a dozer, whose "noise was well below the sounds emitted by closer noise sources such as wind moving the tree leaves, birds, distant traffic, and human activity, the human ear can readily discern changes in pitch of time-varying sounds in the midst of background noise. The reasons for this are many; for example, wind moving tree leaves is a higher frequency sound than the dozer noise. Also, the variation in sound intensity as the dozer was loaded and unloaded aided in

discerning its sound from other ambient sounds. If the intensity of the dozer sound was steady, the listener would not be able to discern it as well. Its noise level (dB) may be less but is a distinctly different sound from others" (Exxon 1984). This could add to the public response to the change in the acoustical environment around the construction site.

Operations Impacts

The major sources of noise during project operation will be associated with the following facilities:

1. Mine/Mill

The major noise sources at the mine/mill site are presented in Table 3-5. The equivalent sound level (L_{eq}) for the mine/mill site is 88 dB at 50 feet.

For assessment purposes, the mine/mill site operations noise was assumed to be located at the northwestern end of the railroad tracks at the load-out.

In addition to the above noise sources, two vent fans -- West Exhaust Raise and East Exhaust Raise -- are considered. The sound level for each unit is 83 dBA at 50 feet.

2. Mine Waste Disposal Facility

The mine waste disposal facility operating noise was assumed to be produced by two trucks at the boundary nearest each noise-sensitive location. Six different locations were used for the contour calculations. The L_{eq} from these two trucks is 91 dBA at 50 feet (Kessler, 1978).

TABLE 3-5

MINE/MILL SITE OPERATIONS NOISE SOURCES

EQUIPMENT	SOUND LEVEL (dB) AT 15 M (50 FEET)
Train/Concentrator	88
Transformer	72
Crusher	65
Batch Plant	67
Air Heater A	68
Air Heater B	68
Compressor	63
East Exhaust Raise Vent (2 units)	83
West Exhaust Raise Vent (2 units)	83

Total Mine/Mill L_{eq} = 88 , dB at 15 m (50 feet), not including east and west exhaust raise vents.

3. Access Road

The noise levels associated with the access road were calculated from the number and types of vehicles that will be traveling along the road during the morning, afternoon and nighttime periods. The L_{eq} from the access road was calculated to be 52 dBA at 50 feet (Federal Highway Administration, 1978). The noise source location for the access road was chosen at the point along the road that is nearest to each noise-sensitive location. Four different locations were used in the contour calculations.

4. Railroad Spur

The railroad spur operation noise level was obtained from the mine/mill noise contours. The locomotive and freight cars have a noise level of 88 dBA at 50 feet. The noise source was located at the northeastern end of the spur.

5. Haul Road

The haul road was assumed to have three heavy trucks traveling at the midpoint of the road. The L_{eq} of 93 dBA at 50 feet results from combining the three truck noise emissions (Kessler, 1978).

6. Pipelines (Tailings Transport and Water Discharge) and Discharge Structure

The tailings transport pipeline, water discharge pipeline, and water discharge structure were assumed to have no operating noise associated with them because they are located underground or in an enclosure.

The A-weighted sound pressure levels and usage factors are consistent with the source sound power level spectrums presented in the Appendix.

The operations noise emissions used in this assessment are "worst-case" levels. At the mine/mill site, it was assumed that all listed noise sources would be in continuous operation, although some may operate intermittently. At the mine waste disposal facility, the trucks were assumed to be at six locations at once, nearest to each noise sensitive location although in actuality they would only operate there for a short time. Railroad spur operations were assumed to be continuous for 24 hours per day. For actual plant operations, there would only be, on the average, 25 railcars per day, which would take less than one hour to travel the length of the spur.

Operation activities would generate additional noise within the local site area. Many sounds would be similar to sounds of an industrial facility operating.

To estimate future (L_{eq}) noise levels and their expected impacts from operational activities the sound power levels spectrum for the equipment used during operation is used to weigh the sounds from a combination sources in the project area.

Table 3-6 contains a summary of the sound level contributions of each noise source during operations. Because no noise is anticipated for the underground tailings transport pipeline and water discharge pipeline and for the water discharge structure, they are not included in this table. This table also contains the summer and winter baseline and operation ambient sound levels and the projected changes from baseline sound levels. The methodology used to estimate noise during operations is described in Appendix A, along with the sound power level spectrum for all equipment used during operation.

TABLE 3-6
OPERATION PHASE EFFECT ON AMBIENT SOUND LEVELS

Location	Baseline, dBA			Operation Noise, dBA		Total Noise During Operations, dBA ¹⁾			Change, dB		
	Ld	Ln	Ldn	LA		Ld	Ln	Ldn	Ld	Ln	Ldn
				Day	Night ²⁾						
Winter											
1	43	30	42	27	27	43	32	43	0	2	1
2	38	29	38	34	34	39	35	42	1	6	4
3	39	24	38	33	32	40	33	41	1	9	3
4	43 ³⁾	35	44 ³⁾	30	29	44	36	45	1	1	1
5	42	38 ³⁾	45 ³⁾	48	47	49	48	55	7	10	10
6	42 ³⁾	20	40 ³⁾	41	40	45	40	48	3	20	8
7	45	42	49	31	30	45	42	49	0	0	0
8	34	31	38	30	29	35	33	40	1	2	2
9	33	30	37	36	31	38	34	41	5	4	4
10	33	31	38	32	26	36	32	39	3	1	1
Summer											
1	47	43	50	27	27	47	43	50	0	0	0
2	42	40	47	34	34	43	41	48	1	1	1
3	44 ³⁾	44	50 ³⁾	33	32	44	44	50	0	0	0
4	64	47	62	30	29	64	47	62	0	0	0
5	57 ³⁾	27	55 ³⁾	48	47	59	47	58	2	20	3
6	38	39	45	41	40	43	43	49	5	4	4
7	48	41	49	31	30	48	41	49	0	0	0
8	41	40	47	30	29	41	40	47	0	0	1
9	43	27	42	36	31	44	32	43	1	5	1
10	39	28	39	32	26	40	30	40	1	2	1

¹⁾ Ambient plus operation phase noise.

²⁾ Nighttime operations excludes MWDF activities.

³⁾ Measured ambient values were adjusted to reduce the contribution from short duration, high sound pressure level sources.

Estimated noise levels from daytime and nighttime operational activities at the ten monitoring sites, Locations A-C, and at other undefined locations in the project area are presented in Figures 3-3 and 3-4. These figures illustrate the property boundary site and areas with isopleths of A-weighted equivalent (L_{eq}) sound pressure levels. Sound levels during normal operations at Locations A-C can be determined from Figures 3-3 and 3-4 and the background ambient sound levels in Chapter 2.1.3.1.

Total noise during winter operations would be less than summer operations as shown in Table 3-6. This is due to lower baseline noise levels during the winter. There would be an increase of 1 dB or less in L_{dn} at Locations 1, 4, 7 and 10. There would be greater increases at Locations 2, 3, 5, 6, 8 and 9. These increases are predominantly due to the contribution from the mine waste disposal facility. At Location 6, the haul road would also contribute to environmental sound levels. L_{dn} noise levels generally increase up to 4 dB, except at Locations 5 and 6 which would experience a 10 and 8 dB increase, respectively.

Residents in the vicinity of Locations 3 and 5 would experience a 9 and 10 dB increase, respectively, in winter nighttime sound levels, while residents near Location 6 would experience a 20 dB increase during the same time period. All other locations would experience noise levels increases up to 6 dB. Nighttime sound levels, L_n , change substantially at Location 6 due to the existing low ambient sound levels. Since a worst-case situation is considered, actual ambient sound levels during operations are expected to be lower.

There would be little or no change (less than one dB) in ambient day-night sound levels in the summer at Locations 1-4 and 7-10 due to project operation. At Location 5, a change of about 3 dB L_{dn} is anticipated, predominantly due to waste disposal activities. This change would not be perceptible. At Location 6, there is a change of about 4 dB L_{dn} , principally due to the haul road. The

estimated noise level contributions are conservative and could probably be lower during most of the actual operations.

Summer nighttime noise levels increase 20 dB at Location 5. All other locations increase 5 dB or less.

Although ambient sound levels would meet EPA's short and long-term goals at all locations except for Location 4 during the summer (does not meet long-term goal), the difference in sound levels is substantial enough such that increases above 10 dB could result in complaints or community action.

Noise impacts during operation would last for longer periods than during construction activities. The overall human response to the operations will be very similar to those discussed in the section on Construction Impacts.

Instantaneous Noise Impacts

The project would produce some noises that are instantaneous in nature, but not unlike those of any similar mining operation. In fact, the short duration of these noise sources is similar to that of intermittent auto, snowmobile, or airplane noise already present in the site area. Examples of the sources capable of emitting instantaneous noise are provided below:

1. Warning Horns - OSHA requirements regulate activities such as blasting. OSHA requires that surface construction blasting be conducted according to 1926.909, Table U-1, which includes the following requirements:
 - a. Warning Signal - A one-minute series of horn's sound five minutes prior to Blast Signal.
 - b. Blast Signal - A series of short horn sounds one minute prior to explosives detonation.

c. All Clear Signal - A prolonged horn sound following the inspection of the area for detonation.

2. Blasting - Surface blasting is not planned as part of the project construction phase activities for the development of the facilities such as the mill, main office building and MWDF. However, large boulders may be encountered in the glacial till during construction activities and may have to be reduced in size by blasting. When bedrock is encountered during shaft sinking, blasting will be required. Sound pressure levels associated with blasting for both of these circumstances will be highly variable and directly related to the geometry of material blasted and quantity of explosives used. (See Appendix A for the equation to determine the noise level resulting from blasting.)

3. Backup Alarms - OSHA Regulations No. 1926.602(a)(9)(ii). No employer shall permit earthmoving or compacting equipment which has an obstructed view to the rear to be used in reverse gear unless one of the following conditions is met: 1) the equipment has in operation a reverse signal alarm distinguishable from the surrounding noise level, or 2) an employee signals to the operator that it is safe to move in reverse gear.

Sound pressure levels for excavation equipment range from 80 to 92 dBA and would likely have alarms 5 to 10 dB greater than the A-weighted sound pressure level of the equipment. The exact levels for the construction equipment are not available. However, construction and operation excavation activities will likely occur under this category.

4. Startup Alarms - Remotely started and stopped equipment may also require alarms. These types of alarms probably will be operated at the minimum noise level consistent with safe operations.

Most alarm devices are high frequency in nature so that maximum benefit can be achieved from atmospheric absorption. This will reduce annoyance to off-site, noise-sensitive locations. Further, the alarm systems on the trucks and other construction phase mobile equipment will be checked to ensure that their sound levels do not exceed the amount required for safety.

Traffic Noise

The Federal Highway Administration (FHWA) equation for predicting noise at distances of 15 m (50 feet) or greater was used to estimate current and project-related noise levels on State Highway 55 north and south of the intersection with the proposed access road. This equation is the same as that used by the State of Wisconsin Department of Transportation. The current and projected vehicle traffic rates, the calculation method used and the estimated differences in L_{eq} as a result of increased project-related traffic during construction and operation activities is presented in Appendix A.

L_{eq} noise levels on SH 55 north of the mine/mill access road would increase 2 dB as a result of increased traffic during construction and 1 dB during operation. South of the access road on SH 55 noise levels would increase 1 dB during both construction and operation. Increases of less than 3 dB would be barely noticeable in the natural environment.

Impacts on Wildlife and Domestic Animals

Very little data exists on the effects of noise on wildlife. An EPA report (1980) (although limited with regard to quantitative information), continues to be one of the more comprehensive reviews available. The report concludes that the principal reaction to transient and unexpected noise by wildlife is startle or fright. Wildlife generally flee from the noise source temporarily, or for long periods if the noise persists. Some wildlife

have a tendency to adapt to noise that is predictable and unchanging. For example, the observed reactions of birds to high noise levels include fright reactions, altered behavior, and, in some cases, attraction to noisy areas.

Specific concerns have been expressed regarding the impacts of seismic noise on bald eagles nesting in the area. A breeding survey was conducted in 1984 by the Department of Natural Resources which showed some degree of eagle activity in Lincoln County. During this survey, seven nests were sighted, five of which appeared to be active. Eight young eagles were counted at this time (Sindelar, 1984). Subsequently, a mid-winter bald eagle survey was conducted throughout the State of Wisconsin. No eagles were reported for Lincoln County at that time (Jurewicz, 1984).

During several interviews with raptor specialists, the opinion was repeated that eagles have individual temperaments. Some have tenacious personalities while others are more prone to disturbance. A report was published in July 1984 by the Bureau of Land Management's Price River Resource Area Office regarding reactions of golden eagle young to surface explosive seismograph testing. Results of the BLM study showed that surface charges fired from a distance of about one mile produced no significant disturbance to young eagles. However, a stipulation was developed to mitigate noise impacts to the birds. The stipulation required a skip in the seismograph line which provided a .5-mile buffer zone around the eagle nest in which no surface shots would be permitted while the nest was occupied. In addition, the birds' behavior would be observed during explosions leading up to and away from the skip.

The U.S. Fish and Wildlife Service has published guidelines on the management of bald eagles. These guidelines also provide for a buffer zone of no activity surrounding an active eagle nest. Because the bald eagle is classified as a threatened species in the State of Wisconsin, it is under the protection afforded by the

Endangered and Threatened Species Act and the Protection of Bald and Golden Eagles Act.

Measures should be taken to establish a buffer zone around eagle nests during construction and exploration activities. In addition, the recommendations set forth under the Federal guidelines should be followed to reduce disturbance to these birds. Any aircraft in the area should be advised to take precautions whenever entering or leaving the area to avoid disturbance to or collision with bald eagles.

Effects of noise on domestic (farm) animals are also not well documented, although there are indications that excessive noise may disrupt their behavioral activities. The major effects appear to be initial fright reactions and temporary increases in heart rate. Domestic animals are located sufficiently away from the proposed activities and should not be affected by noise.

Based on the information presented in the referenced U.S. EPA report, it is anticipated that noise impacts on wildlife will be minimal. In terms of behavioral response, some animals will tolerate increased noise levels whereas others will temporarily avoid such areas. During periods of noise generating activity in the project area (e.g., periods of heavy equipment use during construction), wildlife may temporarily avoid the area where the activity is occurring. However, any noise effect should be localized around the area of activity and should decrease as the distance from the noise source broadens.

3.1.3.2 Vibration Impacts

Explosive Charge Descriptions

1. General

The discussion that follows uses several terms that are defined in the Glossary. It should be understood that the

important blasting charge information related to seismic vibrations that occur some distance from the blast is the weight of charge per delay, not the total charge weight.

2. During Shaft Sinking

Most of the excavation work in overburden soils will be without the use of explosives. However, where boulders are encountered and conventional excavation equipment cannot loosen or break them, small charges will be used.

The explosive charges required for the Main Shaft in bedrock will be 160 kg (352 pounds) of 40 percent or 60 percent straight gelatine dynamite. There will be 15 delays at each firing, with an average of 3.6 kg (8 pounds) per hole and approximately three such holes per delay, resulting in 10.9 kg (24 pounds) per delay period. A maximum of four holes may be used per delay, resulting in a maximum of 14.5 kg (32 pounds) per delay.

For the Intake Air Shaft excavation in bedrock the same general level of explosives, as for the Main Shaft, will be utilized.

East and West Exhaust Ventilation Shafts will have explosives fired twice per day. Each total charge will be 220 kg (485 pounds) of 40 or 60 percent straight gelatine dynamite. However, 15 separate delays will be used, with an average of four holes per delay at approximately 3.8 kg (8.4 pounds) per hole, or approximately 15.2 kg (33.5 pounds) per delay period. A total maximum of six holes might be fired on one delay, with a total weight of 22.8 kg (50.2 pounds).

3. Production Blasting in Stopes

The upper part of the work will require as much as 8,000 kg (17,600 pounds) per firing, but with the use of many delays. In the work above the 140 m level, it is anticipated that single delays will be designed to have no more than 250-300 kg (550-660 pounds) per delay. There is little probability that all delays (the entire 8,000 kg [17,600 pounds]) would be fired simultaneously.

Below the 140 m level, the usual blast will require 8,000 kg (17,600 pounds) overall, but in six delays, with 1,330 kg (2,925 pounds) per delay. Simultaneous firing of all charges is unlikely.

There is a possibility that larger charges per delay would be utilized (Exxon, 1985). However, blasting will be limited so as to not exceed a peak particle velocity of 2.0 inches per second at on-site facilities.

Inspection of Figures 3-5 through 3-12 indicates the following possible charges per delay:

<u>Level in Mine</u>	<u>Maximum Charge Plotted (For 2.0 inches/sec.)</u>	<u>Distance from Blast (Meters)</u>
95M	4,000 kg	120
140M	10,000 kg	200
290M	20,000 kg	200

Evaluation Methods

1. Analytical Methods

Peak particle velocity will be the primary factor utilized in all evaluation methods. Figure 3-13 indicates the assumed cross section and the results of using the Hoek and Brown

Figure 3-5

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

8000KG

4000KG

1000KG

500KG

— * —

— + —

— ▲ —

— □ —

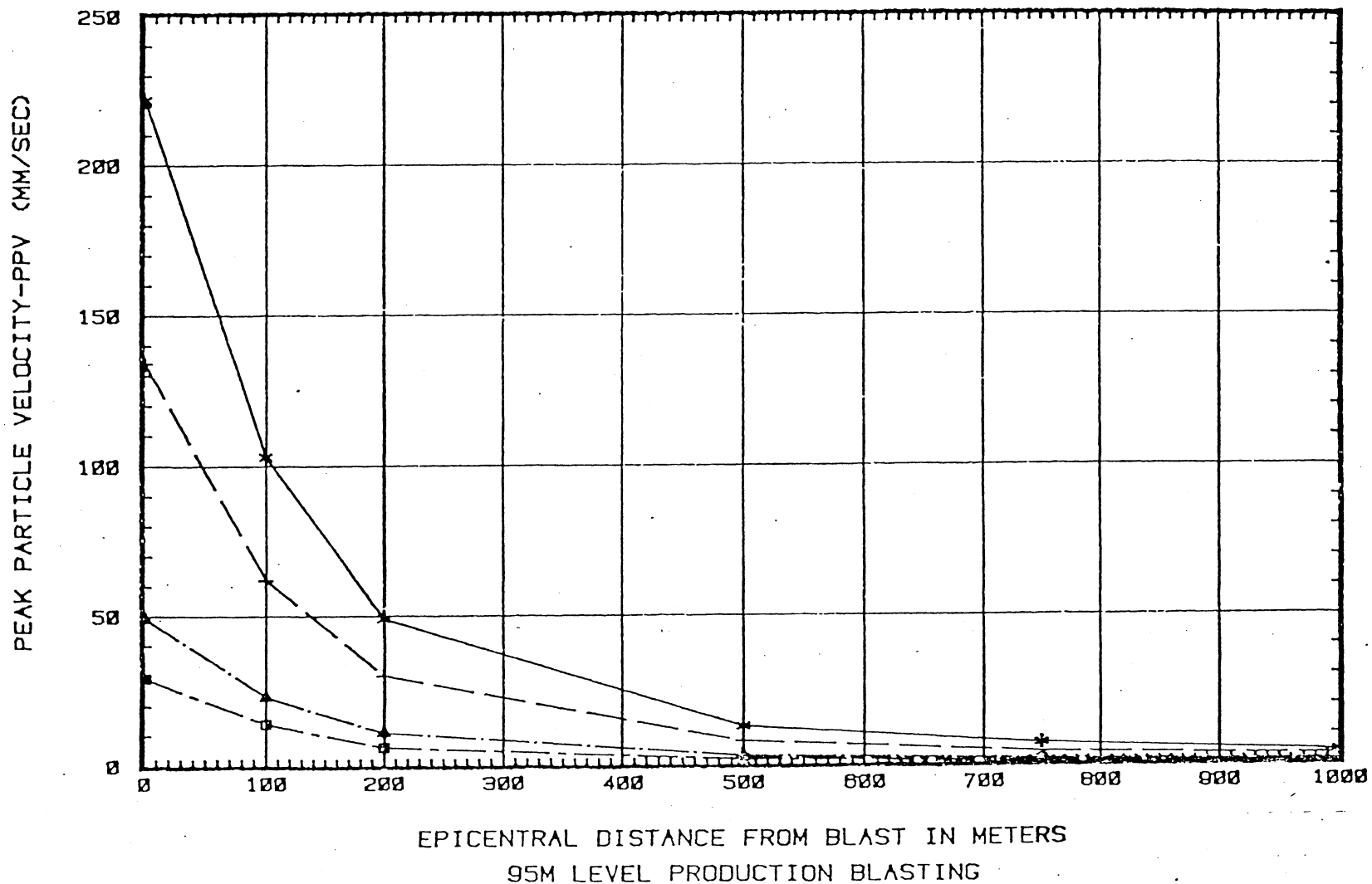


Figure 3-6

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

8000KG

4000KG

1000KG

500KG

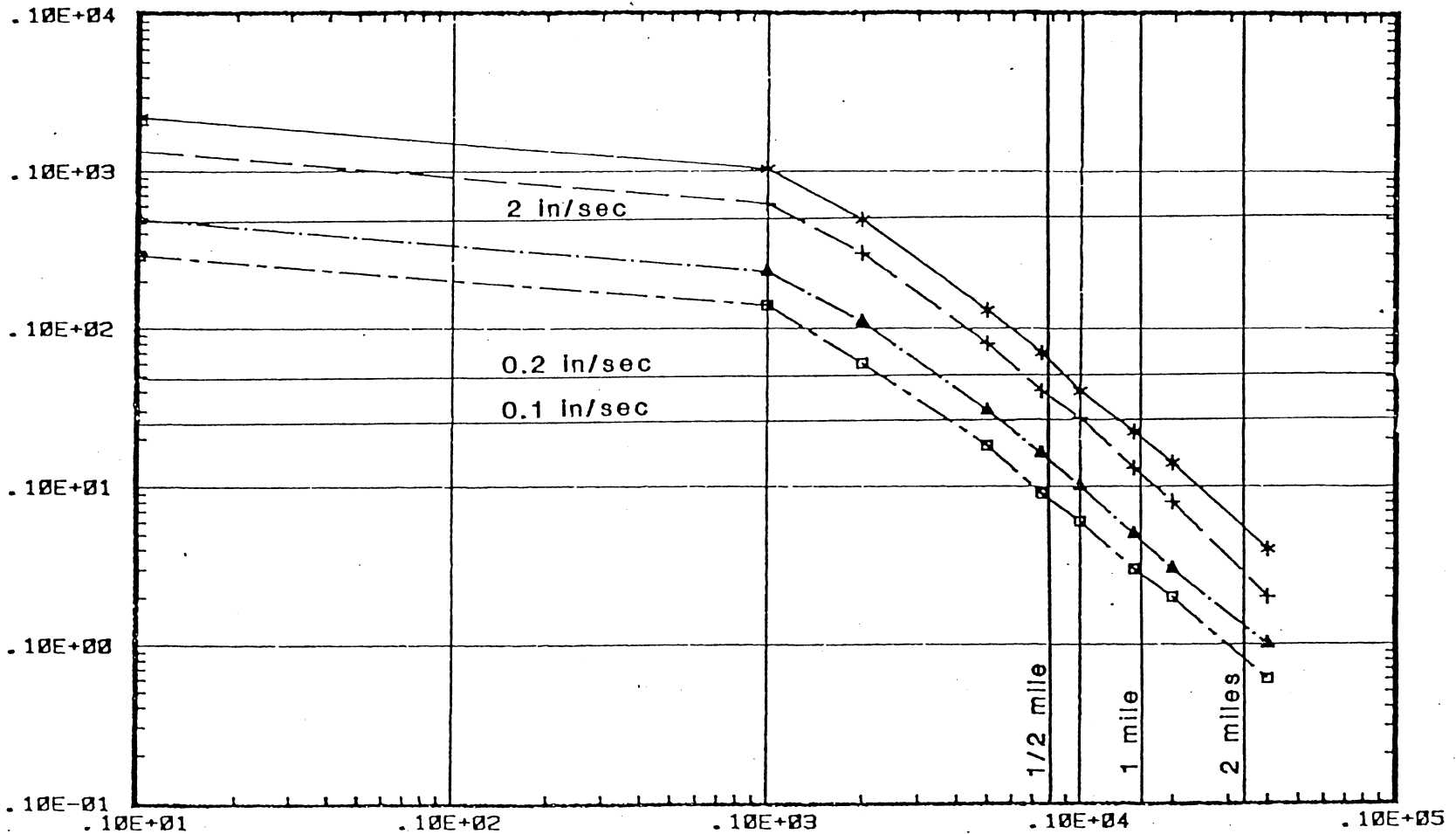
— * —

— + —

— ▲ —

— □ —

PEAK PARTICLE VELOCITY-PPV (MM/SEC)



EPICENTRAL DISTANCE FROM BLAST IN METERS

95M LEVEL PRODUCTION BLASTING

Figure 3-7

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

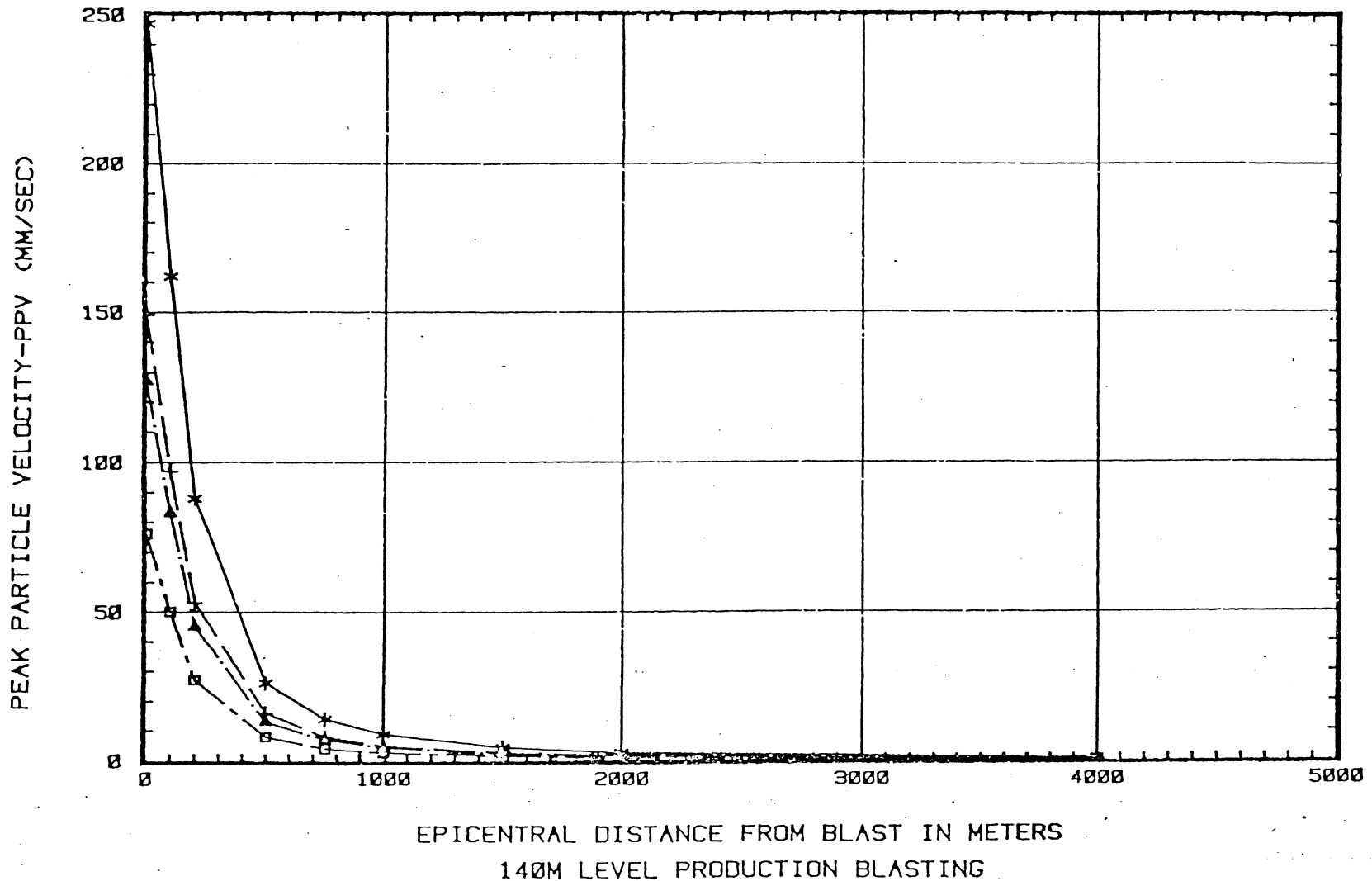
4000KG

— * —

— + —

— ▲ —

— □ —



CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

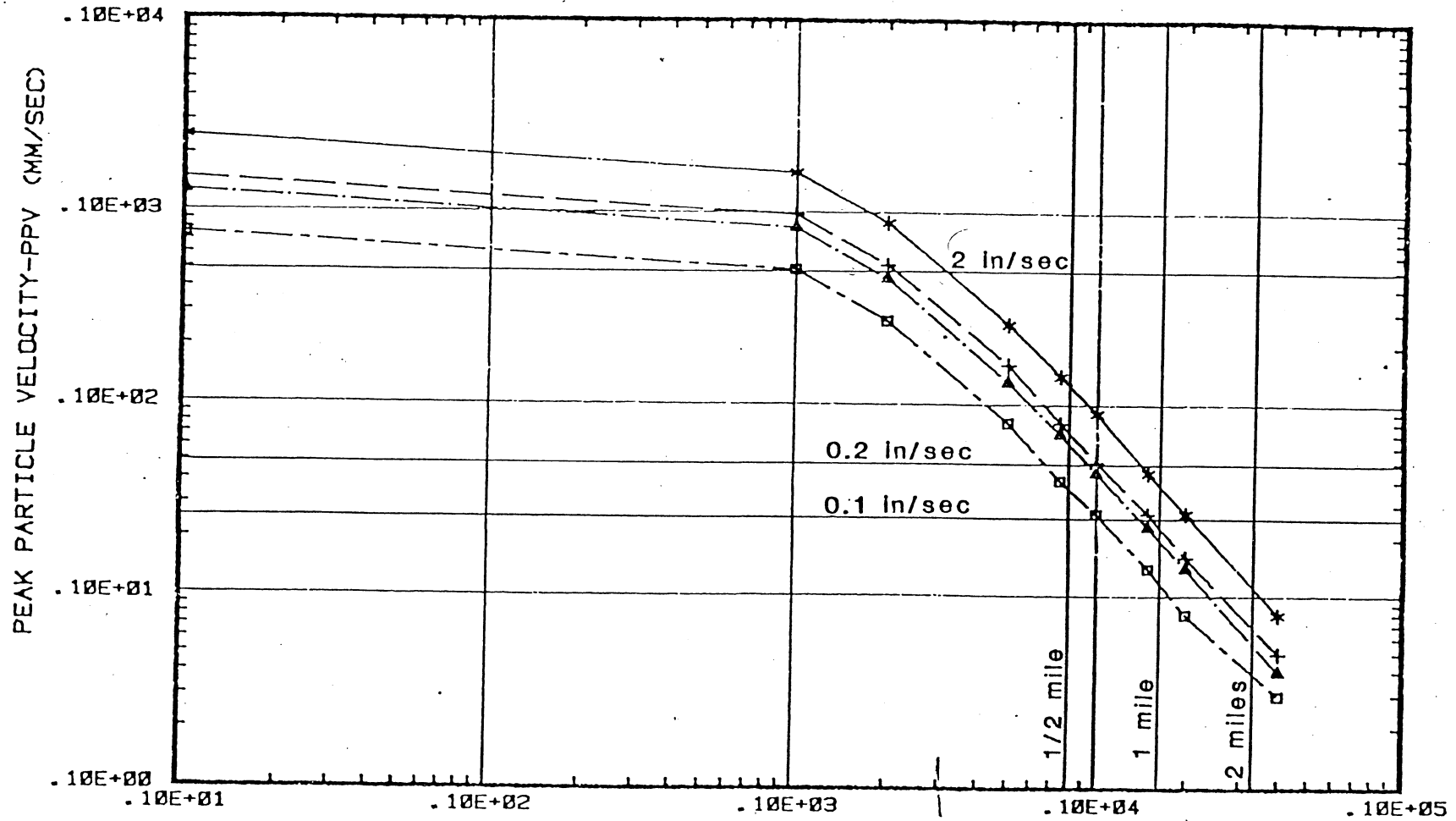
MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

4000KG



EPICENTRAL DISTANCE FROM BLAST IN METERS
140M LEVEL PRODUCTION BLASTING

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

4000KG

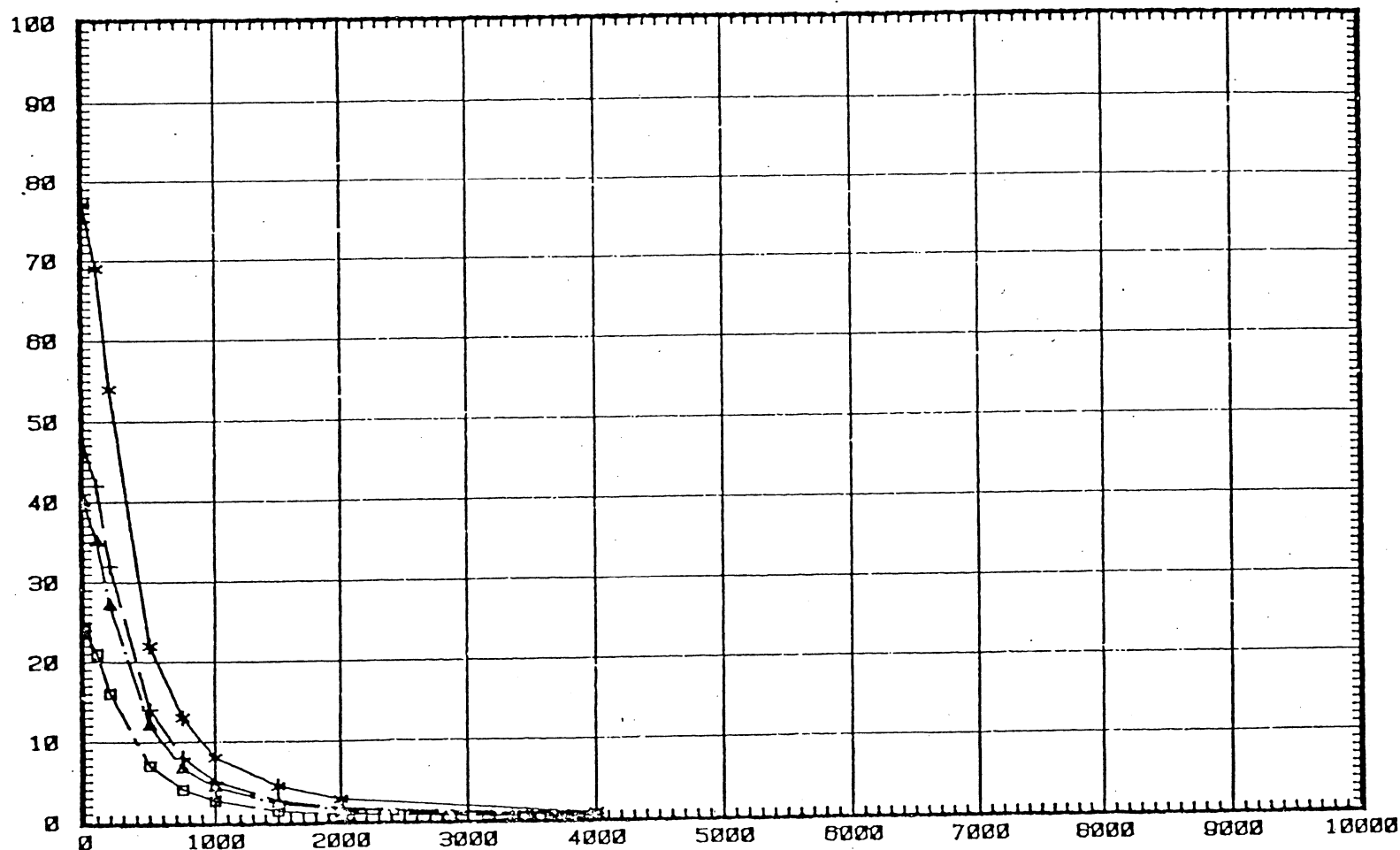
— * —

— + —

— ▲ —

— □ —

PEAK PARTICLE VELOCITY-PPV (MM/SEC)



EPICENTRAL DISTANCE FROM BLAST IN METERS

290M LEVEL PRODUCTION BLASTING

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

4000KG

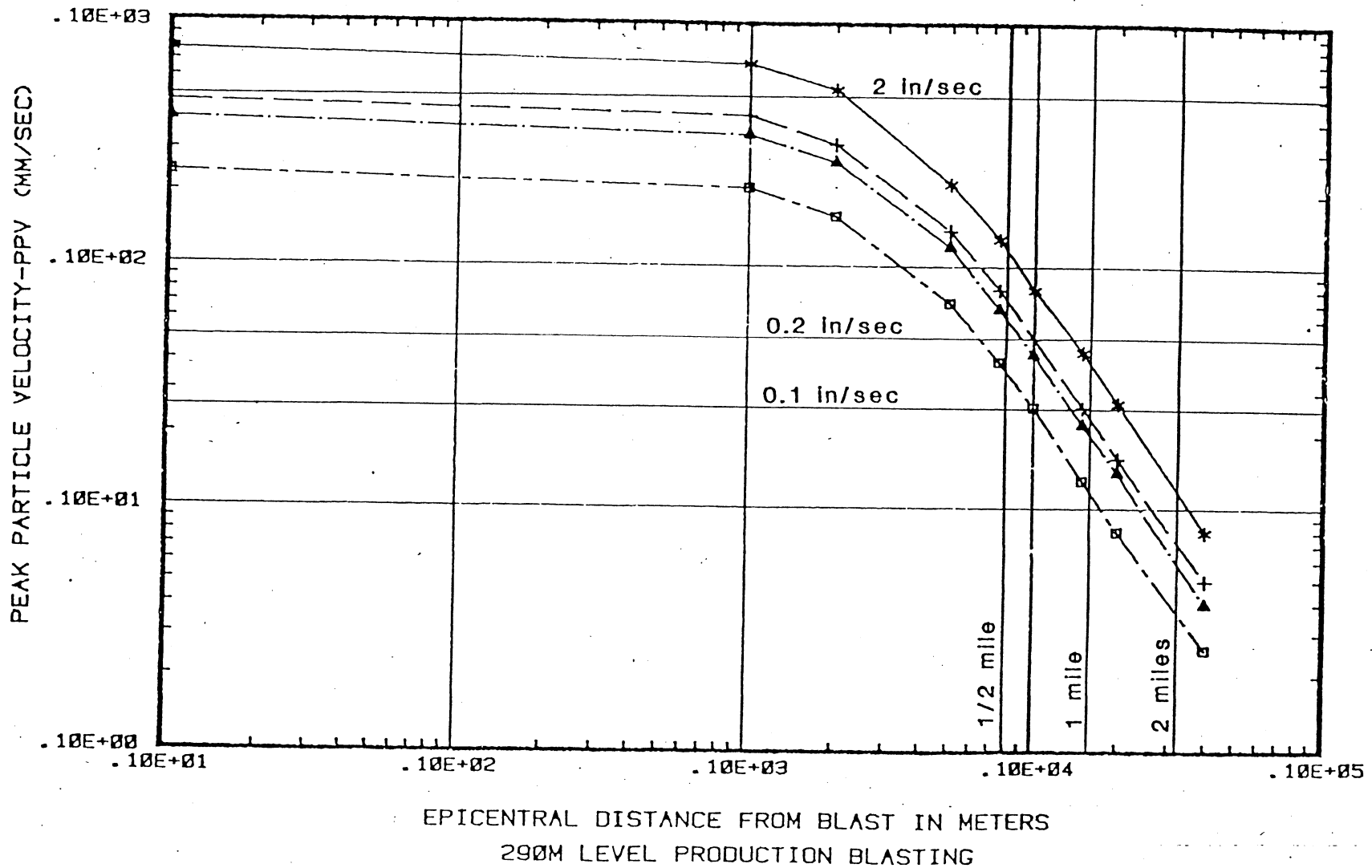


Figure 3-11

CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

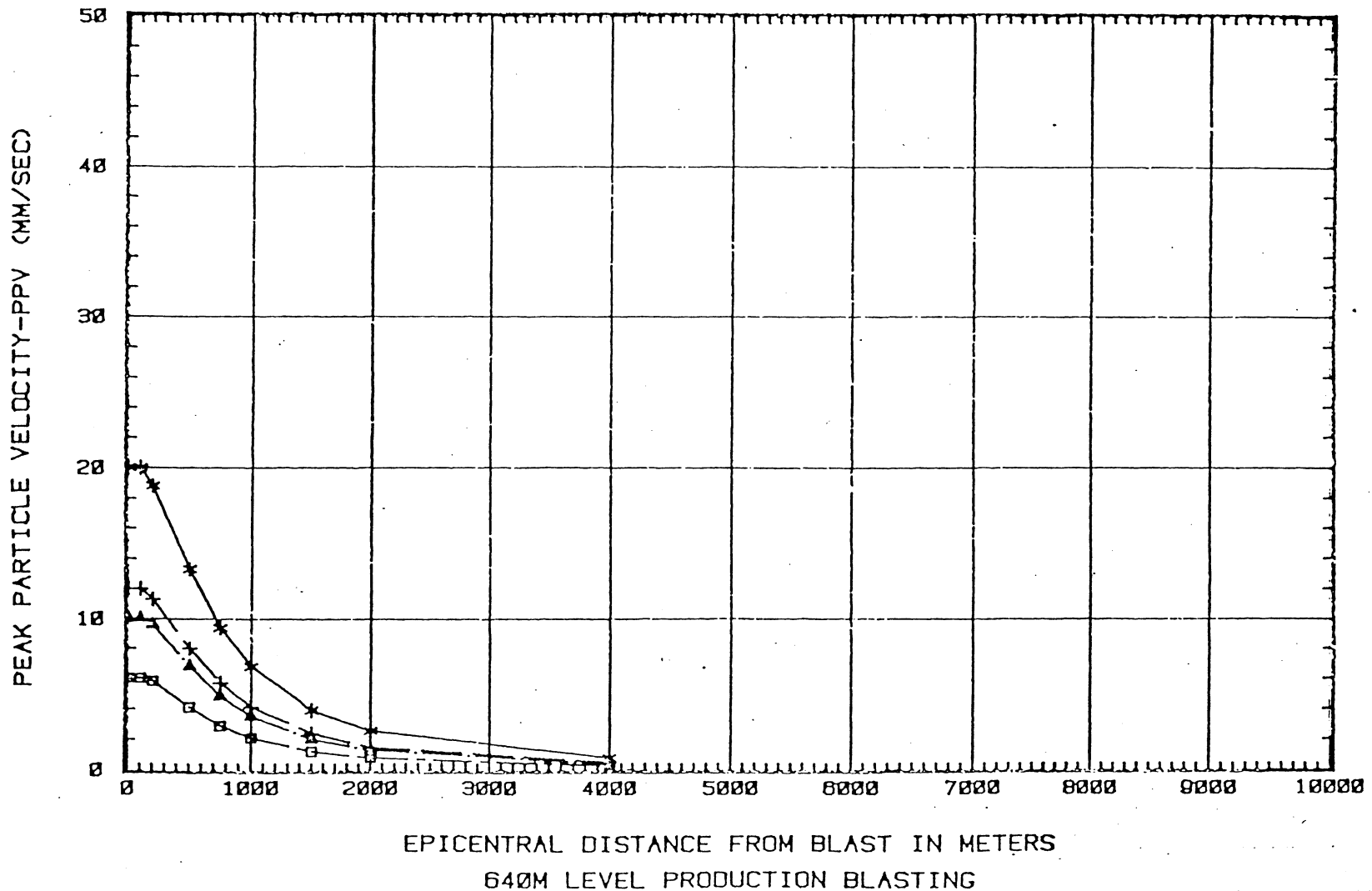
4000KG

— * —

— + —

— ▲ —

— □ —



CRANDON PROJECT

ESTIMATED GROUND SURFACE PEAK PARTICLE VELOCITIES

MASS OF EXPLOSIVES
PER DELAY

20000KG

10000KG

8000KG

4000KG

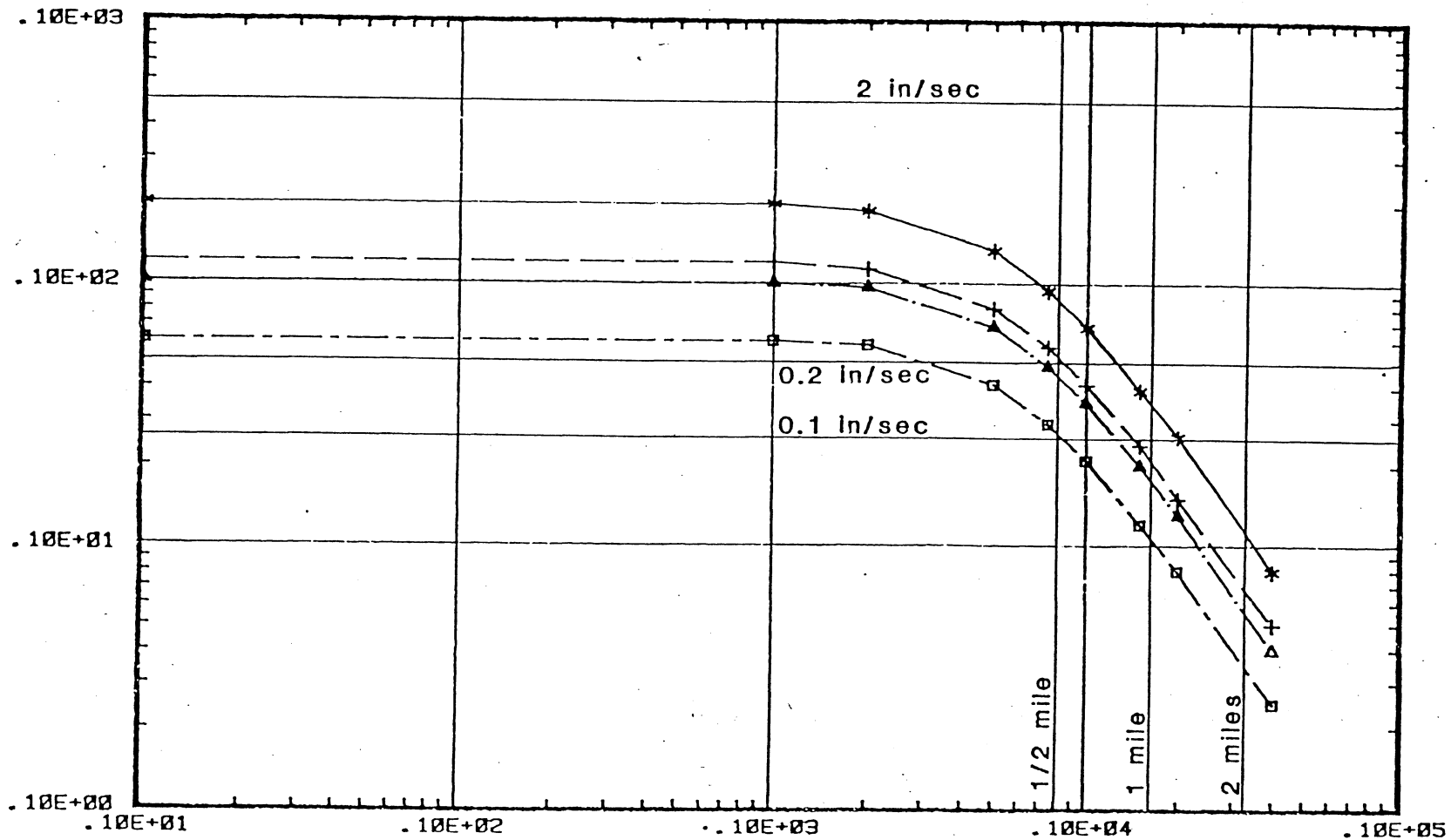
— * —

— + —

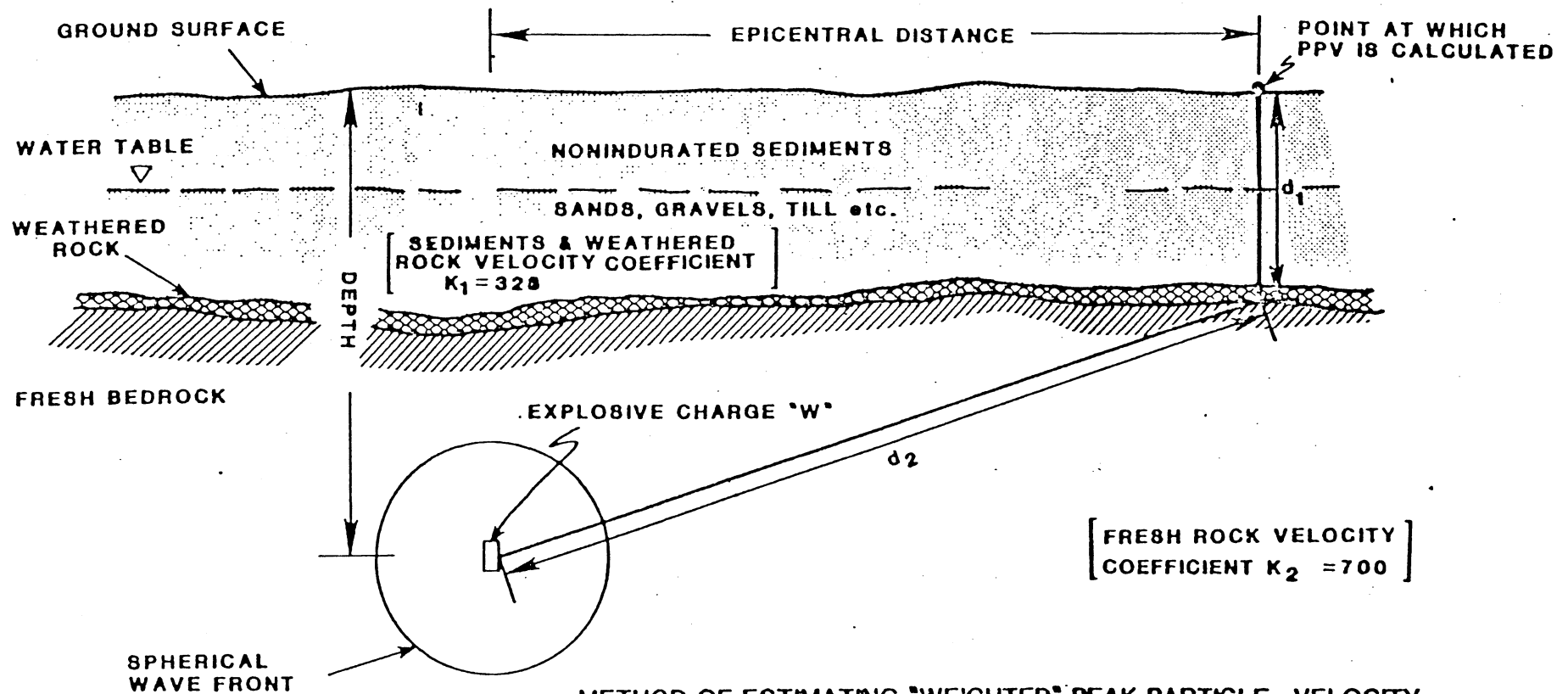
— ▲ —

— □ —

PEAK PARTICLE VELOCITY-PPV (MM/SEC)

EPICENTRAL DISTANCE FROM BLAST IN METERS
640M LEVEL PRODUCTION BLASTING

CRANDON BLASTING VIBRATION ESTIMATE PEAK PARTICLE VELOCITY MODEL



METHOD OF ESTIMATING "WEIGHTED" PEAK PARTICLE VELOCITY

$$\text{PEAK PARTICLE VELOCITY (PPV) (mm/sec)} = (1.8) \left[\frac{d_1}{R} K_1 + \frac{d_2}{R} K_2 \right] \frac{W^\alpha}{R^\beta}$$

WHERE:

K_1 = VELOCITY COEFFICIENT FOR NON-INDURATED SEDIMENTS (328)

K_2 = VELOCITY COEFFICIENT FOR FRESH ROCK (700)

d_1 = DISTANCE WAVE FRONT TRAVELS IN NON-INDURATED SEDIMENTS, (m)

d_2 = DISTANCE WAVE FRONT TRAVELS IN FRESH ROCK (m)

$R = d_1 + d_2$ IN METERS

W = CHARGE WEIGHT (kg)

$\alpha = 0.73$

$\beta = 1.75$

mathematical model for predicting the levels of particle velocity that will develop as a result of any given blast. The peak particle velocity is generally expressed by the equation:

$$V_p = k W^{\alpha} / R^{\beta}$$

where:

V_p = Peak particle velocity (mm/s)

W = Explosive charge weight (kg)

R = Hypocentral distance to the point of estimated peak particle velocity

k = Velocity coefficient (empirical)

= Exponent (empirical) assumed as 0.73

= Exponent (empirical) assumed as 1.75

The velocity coefficient (k) for the particular material through which the wave passes has been assumed as follows:

In non-indurated sediments $K_1 = 328$, in Fresh Cambrian Bedrock $k_2 = 700$.

The path through which the wave passes with the least attenuation is predominately within bedrock, with the path in overburden soils governed by the laws of refraction. Figure 3-13 indicates an approximate representation of the probable path. The equation also is modified to account for the material through which the wave passes.

On the basis of this technique, various charge weights and distances from the blast were used to develop charts depicting the estimated Peak Particle Velocity that might be expected

for both the shaft sinking process and the production blasting. These charts, as prepared by EXXON, are presented in Figures 3-5 through 3-13.

2. Theoretical Methods of Evaluating Vibrations

Figures 3-5, 3-7, 3-9 and 3-11 are linear in the plotting. For purposes of estimating the lower levels that might be felt at some distance from the blasts, the corresponding Figures 3-6, 3-8, 3-10 and 3-12, have been prepared on log log scale to permit the estimating of the peak particle velocity levels with some degree of precision.

For comparison purposes, the 0.01 to 0.1 inches per second range for the limit of human response is roughly equivalent to the vibrations that one would feel in a house located about one city block from a fast freight railroad. It is noted that several of the situations plotted on Figures 3-6, 3-8, 3-10 and 3-12 at distances of one-half to one mile are predicted to be in this category. Higher peak particle velocity is predicted at less than one-half mile for some of the heavier charges. EXXON does not intend to exceed 2.0 inches per second peak particle velocity for nearby structures, say less than 200 meters from the blast site. However, there is the possibility, due to orientation of the blast site with respect to the nearest EXXON structure, that private structures may be as close to the blast site as the EXXON structure being monitored. Thus, there are potential situations where the non-EXXON-owned structures may receive seismic vibrations that are in the unpleasant category, or possibly in the category where cracks in plaster walls may occur.

A summary of Bureau of Mine data on the probability of complaints, possible damage and the like for various levels of response is included in Figure 2-2.

A different chart on the same subject is presented in the text "Vibrations of Soils and Vibrations" by Richart, et al., included herein as Figure 3-14. It will be noted that the Figure 2-2 indicates the peak particle velocity that is barely noticeable to persons is 0.1 inch per second while the Figure 3-14, shows the same description for a velocity of 0.01 inch per second. This is a ten-fold difference, indicating the approximate nature of the field of human response prediction for blasting situations.

Quoting from Richart, et al., Page 317, "The physiological vibration limits represent only the first step in evaluating the effects of vibrations on persons. The next and often the more important consideration is the psychological effect on persons. If the vibration is being generated "in his interest," then a person may accept the physiological vibration limit. However, if the vibration is generated "for someone else's benefit," a vibration which is "barely noticeable" may be effectively transformed into the "troublesome" category.

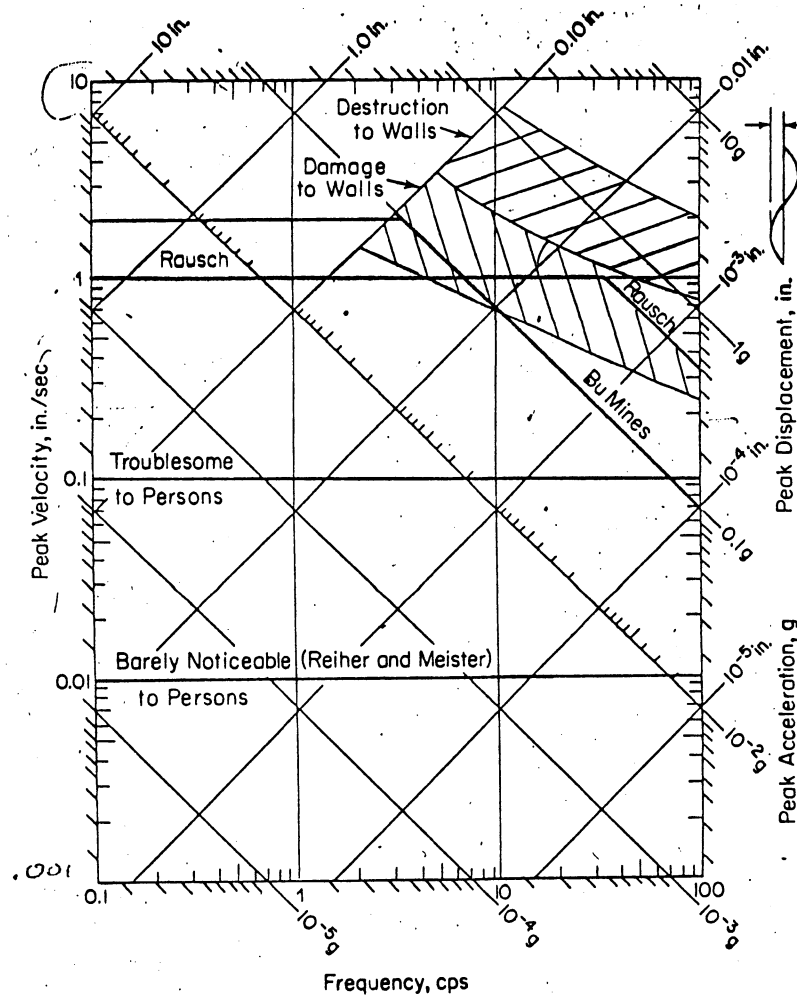
Time can change the human response descripton for seismic vibrations of a low level. Take the case of a new interstate highway being built in a rural area. No doubt the persons so affected disliked the vibrations and noise at the beginning, but in time, become so accustomed to it that they do not notice it.

Affects on Structures

1. On-Site Structures

The information presented in Chapter 1 indicates that damaging vibrations will not be produced on-site, as a result of a combination of designed blasts and use of monitoring at each new level of blasting. This is expected to produce a condition of minimal visible blasting effects on the EXXON structures. A

Figure 3-14
Levels of Complaints and
Damage from Vibration



safe level of blasting vibrations is 0.75 inch per second for modern homes with gypsum board interiors (Bureau of Mines, 1980). Figures 3-5 through 3-12 indicate that on-site structures will probably have more than this limit. The 2.0 inches per second limit set by EXXON may be too high to preclude some wall crack damage developing on-site and at the non-EXXON structures near the mine.

2. Off-Site Structures

Figure 3-10 indicates that 20,000 kg per delay will produce a predicted 0.5 inch per second peak particle velocity at one-half mile from the blast. Assuming that this is near the easterly shaft, Figure 1-2, would indicate that numerous residential structures are located within such a limit. Presumably, EXXON would not continue with the blasting that would create more than 2.0 inches per second peak particle velocity at the on-site structures, thus the continuing blast vibration at one-half mile will be less than 0.5 inch per second peak particle velocity, but probably above 0.2 inch per second. The structures closest to the blast would be subjected to approximately 0.5 inch per second peak particle velocity, possibly more. As noted above, there are rare possibilities when the seismic vibration that could occur at non-EXXON structures might be equal to those experienced at EXXON-owned structures. The paper referenced in the above on-site discussion indicates that studies have shown older residential structures with plaster on wood lath construction for interior walls have a five percent probability of developing very superficial cracking at a peak particle velocity of 0.5 inch per second. What this tells us is the structures within one-half mile of the blasts are within the influence of the largest blasts for developing minor cracks in plaster walls.

Due to the approximate nature of the prediction techniques available, it is to be expected that the above statements may either somewhat exaggerate or underrate the degree of potential wall cracking that will develop, especially when the long-term effects of fatigue enter the picture.

Also, since there is apparently consideration, by EXXON, of use of smaller weights of charge per delay, the maximum of peak particle velocity, as discussed herein is on the high side of the average that might be expected.

Affects on Persons

As might be surmised by these discussions, the tolerance of structures to seismic vibrations is usually much higher than human tolerances. For this reason, it is considered that human response will be the more important consideration when analyzing the level of seismic vibrations and the effects.

By utilizing the above estimates for peak particle velocity at the residences along the north side of Little Sand Lake, and using the comments and figures of this EIS, it is obvious that the persons within one-half and probably one mile of the mine blasting will notice the vibrations. Estimated peak particle velocity in Figure 3-10 show 0.5 inch per second can be expected within one-half mile of the blast for the higher blast weights.

A level of vibration in the 0.5 inch per second peak particle velocity is well above what commonly is considered a suitable level for occasional quarry blasting near residential areas. In Janesville, Wisconsin, it was found that it was necessary to reduce the level of peak particle velocity at the closest residence to 0.2 inch per second to reduce the level of complaints from the general area to a "tolerable level". In that case, approximately four blasts took place over a period of two weeks. Even at 0.2 inch per second for the closest residences, complaints

still came in from within the next one-half mile away from the blast.

The actual damage to the off-site structures at Crandon is expected to be either very light or none, but persons exposed to the higher levels of blast vibrations can become very annoyed. This is especially probable, as Richart states, when it is not "done in their interest". The level of complaints is expected to be under ten percent probability, according to Figure 2-2 in Chapter 2. However, that chart is based on conditions probably different than at the Crandon site. Whether or not complaints and human response will be different from Figure 2-2 is not predictable. The available information does indicate that the potential for significant complaints is present for the higher level of blasts anticipated, when the peak particle velocity is near 0.5 inch per second.

CHAPTER 4 - ALTERNATIVES TO THE PROPOSED ACTION
AND THEIR ENVIRONMENTAL IMPACTS

4.5 Noise and Seismic Vibration Control Alternatives

4.5.1 Noise Control Alternatives

Acoustical abatement measures for various sources would be developed to reduce noise levels, especially at night. Although impacts may be minimal, residents would still hear the mine and related activities. To develop harmony with residences, a noise abatement plan would be developed.

The primary objective of the noise abatement measures is to mitigate the construction and operation sounds (noise) within a reasonable distance from the project site. Abatement of all projected noise sources is not possible. Therefore, those sources most likely to affect residential and working areas will be mitigated.

Two types of mitigative controls would be used to manage these activities: Administrative and Engineering.

Administrative controls are generally modifications to operating procedures or work practices which serve to reduce, eliminate, or shorten the duration of the noise source. This type of control is most effective for transient sources. Operating procedures are often directed at controlling workers' actions, and therefore, controlling the noise produced by those actions.

Engineering controls are associated with physical changes to the noise source. This type of control may take the form of source relocation, source replacement and source modification (e.g., addition of a muffler to a diesel engine). Engineering controls are specific to the noise source.

A number of noise abatement measures would be common during the construction, operations, and reclamation phases of the project. These include:

Administrative

1. Posting of speed limits.
2. Limiting tree removal on the site to only those areas requiring immediate construction.
3. Re-establishment of vegetative species in the site areas soon after construction is completed.
4. Limiting engine idling of mobile equipment during periods of inactivity.
5. Limiting certain activities to daytime hours, where feasible. Such activities would include: daytime construction of the MWDF, access road, railroad spur and general surface facilities. It must be recognized, however, that certain circumstances may result in periodic nighttime activities.
6. Movement of trains by the Soo Line on the spur would normally occur during the daytime. However, concentrate loading occurs continuously, so there will be some movement and placing of rail cars within the plant area at night.

Engineering

1. The noise modeling activity begun during the permitting procedures will be continued during the equipment procurement stage. For equipment items that have been identified as potential major noise sources, purchase inquiries and requisitions would include a request for vendors to supply sound power level and sound pressure level data. With this information, the noise model

could be periodically updated, if necessary, so that cost-effective alternatives for achieving noise control can be evaluated.

2. Installation and maintenance of mufflers on all internal combustion engines.
3. Maintenance of equipment to assure proper operating conditions thus minimizing noise levels.
4. All ore processing equipment would be contained within buildings or other enclosures.
5. Enclosing other equipment with large noise generation potential in special enclosures. Such equipment would include the air compressors and emergency electrical generators.
6. Transformers would not be enclosed. The noise modeling results indicate that the contribution to off-site noise levels by the transformers is minimal. Therefore, enclosing them would be of little benefit.

Other specific activities with noise potential would be controlled as follows:

Mine Ventilation Fans

The mine ventilation fans would operate continuously. To mitigate these noise sources, the following actions would be taken:

1. Fans would be selected with emphasis placed on the unit exhibiting the lowest overall sound power level.
2. The discharge structure would be directed vertically.

Mine Air Heaters

Reduction of noise from the mine air heaters would be achieved in the following ways:

1. An air mixing system would be used in which a fraction of the total air is heated to a high level and mixed with unheated air.
2. Noise output level would be a major factor in selection of the fan.

Shaft Excavations

The noise associated with the shaft collar excavation from surface to bedrock would be similar to that of other construction equipment. When blasting is initiated, sounds would be greatly reduced by closing the shaft doors and because of depth (21-51 m [70-170 feet]).

The above facilities and practices have been reflected in the noise modeling conducted to assess noise impacts.

Pipelines and Discharge Structure

Operation of these structures would not have a discernible noise level because the components would be enclosed or underground.

East and West Exhaust Raises

The fan stations located at the east and west exhaust raises (shafts) were remodeled using an octave band spectrum that relates to the specific model of fan required and the fan arrangement according to current design criteria. The actual model of fan installed may vary from that modeled, but the overall sound pressure level would not exceed 83 dBA at 50 feet.

The steady fan noise would be heard at various monitoring sites, especially at night. The exhaust raises would operate 24 hours a day.

The noise contribution from the east and west exhaust raises is limited to less than 1 dBA at distant locations when considered with all other project noise sources. As described in the noise control measures, the contribution of these fans and all other potential major noise sources would be re-evaluated during equipment procurement and detailed engineering.

4.5.2 Seismic Vibration Control Alternatives

Alternatives to Minimize or Prevent Structural Problems Off-Site and to Prevent Disturbance to Persons

The most obvious alternative to the causing of structural problems, such as wall cracking in residences, is a reduction in the level of blasting charges per delay. This can be accomplished by one of two possible methods:

1. Reduce the total charge in each blast. This would require more frequent use of charges, but would create less peak particle velocity at distant points.
2. Use more delays than current plans indicate and divide up the total charge per blast accordingly. It generally has been found that the charge per delay controls the peak particle velocity that is experienced some distance from the blast site. Use of more delays sometimes provides for better, more efficient use of explosives. In that case, the overall total charge weight may also be reduced to some degree.

In scientifically predicting future, higher level blast effects, or for reducing the charge per delay, or the overall weight of the charges, a detailed monitoring program is required. This requires

the use of numerous monitoring stations at regularly spaced distances well beyond the expected range of the minimum levels of peak particle velocity. It would appear that monitoring out to two miles from the site in all directions would be required. It is estimated that approximately ten such sites would be required at any one blast monitoring. Then, on the basis of measured site responses, the overall picture would be clearer to all persons concerned, and an appropriate level of charge per delay could be established.

No intent is indicated for monitoring experimental blasts before the actual need for explosives to accomplish the various tasks. While there is an intent indicated in submittals from EXXON, to perform monitoring of actual construction and production blasts, the plan is not detailed and is not described with the intent of preventing complaints before they occur.

A "Before Blasting Experimental Monitoring Plan" would need to include a map showing the locations of monitoring stations, descriptions of monitoring equipment, a discussion of how the results will be examined, and discussion of what level of peak particle velocity at individual off-site locations would be expected as result of the study.

APPENDIX A
NOISE ANALYSIS METHODOLOGY

MEASUREMENT AND ANALYSIS

Background - The range of sound pressure that can be heard by humans is very large, varying from sounds that are barely audible to sounds that are so loud as to be painful. The decibel (dB) notation system uses logarithms to compress this wide range of sound pressures to convenient quantities called sound pressure levels (Beranek, 1971).

$$\text{Sound pressure levels (dB)} = 20 \log_{10} \frac{P}{P_0}$$

where:

P_0 = Sound pressure required for a threshold sensation of hearing; equal to 20 Pa (micropascals, where 1 micropascale = 10^{-6} newton per square meter) or 0.002 atmosphere; and

P = The measured sound pressure in micropascals or atmospheres.

On the decibel scale, 0 dB is assigned to P_0 . Approximately 125 dB is the sound level at the threshold of pain (U.S. Department of Labor, 1980).

The human ear does not perceive sounds at low frequencies in the same manner as those at higher frequencies. Sounds of equal intensity at low frequency do not seem as loud as those at higher frequencies. To simulate the human ear in evaluations of hearing damage risk or community annoyance impacts (Peterson and Gross, 1967), sound analysis systems incorporate an A-weighting network (American National Standards Institute, 1971a). A-weighted sound levels are expressed in decibels (dB) and are used in Federal, state, and local noise (unwanted sound) ordinances.

Because sound is not constant with time, statistical analysis is used to describe the temporal distribution of a sound and to compute single-number descriptors for that sound. The following statistical, A-weighted sound levels (National Academy of Science, 1977; Bureau of National Affairs, 1978) are used in this analysis.

L_{90} The sound level exceeded 90 percent of the time during the measurement period, often called the residual sound level.

L_{50} The sound level exceeded 50 percent of the time during the measurement period; the median sound level.

L_{10} The sound level exceeded 10 percent of the time during the measurement period, often called the intrusive sound level.

L_{eq} The equivalent steady sound level that provides an equal amount of energy as the time-varying sound.

L_d Day sound level, L_{eq} for the daytime period (0700-2200) only.

L_n Night sound level, L_{eq} for the nighttime period (2200-0700) only.

L_{dn} Day-night sound level, defined as (U.S. EPA, 1974):

$$L_{dn} = 10 \log_{10} \frac{(15 \times 10^{(L_d/10)}) + (9 \times 10^{(L_n+10)/10})}{24}$$

NOTE: The EPA adds a 10 dB correction factor to the night sound level as a weighting to compensate for the greater annoyance of nighttime noise (U.S. EPA, 1974).

Measurement Program - Ambient sound measurements were made during both winter and summer conditions. Measurements were made with a magnetic tape recorder data acquisition system consisting of a GenRad one-inch electret condenser microphone with windscreen, a GenRad Type 1933 Sound Level Meter, and a Nagra 4.2L single trace magnetic tape recorder. In each location, the microphone was located four to five feet above the ground and at least 12 feet from any large reflective surface. The microphone was removed

1) Acoustic energy can be defined as follows: "Acoustic" means of or relating to sound; therefore, the sound energy of the given part of a medium is the total energy in this part of the medium minus the energy which would exist in the same part of the medium with no sound waves present (American National Standards Institute, 1971b).

from the sound level meter and connected to it by a 100-foot cable so that the observer and the tape recording system would have no effect upon the sound data received. The system was calibrated before each measurement period with a GenRad 1562A calibrator at 1,000 Hz (114 dBA).

Linear and A-weighted sound level data were noted on the field data sheets as a check on analyzed data. Noise levels were recorded and analyzed in the consultant's office, not in the field.

During the data recording period, meteorological parameters that could affect that ambient sound were recorded on a data sheet, including wet bulb and dry bulb temperatures (determined by a Bacharach hygrometer), barometric pressure, wind speed and direction (determined by a Sims BX anemometer). If wind speeds were greater than 12 mph or if humidity exceeded 95 percent, monitoring was discontinued, which is standard operating procedure. In addition, all contributing sound sources, such as wind gusts and human and animal activity, were identified.

Instrument calibration to a prerecorded tone of known acoustic pressure was undertaken in the field prior to each measurement. Background sound levels were recorded for continuous periods of 16 to 21 minutes, a time period considered sufficient to describe the character of the ambient sound (Safeer et al., 1972).

Sound level recordings for both winter and summer survey measurements were made during daytime (0700-1800), evening (1800-2200), and nighttime (2200-0700) periods. These periods are in accordance with the daytime (daytime and evening) and nighttime periods used by the U.S. EPA in its definition of day-night sound levels (U.S. EPA, 1974).

Analytical Procedures - The data recorded on magnetic tape were returned to the acoustic laboratory at Dames & Moore for statistical analysis by a computer-controlled data analysis system consisting of a GenRad real time analyzer and a Digital Equipment Corporation minicomputer.

Analog data from the tape recorder were sampled after prefiltering by the A-weighting network; the sampled data were converted to digital binary form, and the binary numbers were used in the minicomputer to compute mean square level. Each sample was used to construct an A-weighted sound level histogram, indicating the number of times a particular sound occurred during the measurement period, and a cumulative distribution of the A-weighted sound levels, indicating the percentage of time a sound level was exceeded during the measurement period.

Field Procedures - At each measurement location for each measurement period, a log of important information was maintained. The sound level meter setting, the weighting network, and the instrument response ("fast" or "slow") were noted. Noise sources observed by the operator were recorded, as were the times when overloads or intrusive noises occurred. Meteorological parameters that might affect sound quality were also noted, and measurements were made only when those parameters were within specified operating ranges for the instrumentation used.

The sound level recording system was calibrated before the acquisition of data using a GenRad 1562-A sound level calibrator. A 114 dB, 1,000 Hz tone was recorded on magnetic tape at the start of each measurement period.

The tape recorded data were analyzed using a Digital Equipment Corporation PDP 8/a digital computer controlling a GenRad real time analyzer, whose input was from a Nagra 4.2L tape recorder. The calibration tone recorded on magnetic tape in the field was used to calibrate the data analysis system. Once calibrated, the computer controls the analysis and prints the results without operator interface, thus maintaining a high quality of analysis.

NOISE IMPACT CALCUALTIONS

Construction and Operation - Noise levels from the different construction and operation sources are used to determine impact of the mine on receptors in the project area. Quantification of the impact of construction and

operation activities on the ambient environment is based on the following hemispherical dispersion model (consistent with Beranek, 1971):

$$L_p(f) = L_w(f) - 10 \log 2\pi r^2 - A_1(f, t, h) - A_2(f) - A_3(f) - A_4(f) - A_5(f)$$

The variables are defined as follows:

L_p = Sound pressure level, dB re $20 \mu\text{Pa}$, at receiver location.

f = Frequency, Hz

L_w = Source sound power level, dB re 10^{-12} W. If the source is other than omni-directional, the sound power may be adjusted to account for source directivity.

r = Distance between source and receiver, in meters.

A_1 = Molecular air absorption attenuation, dB as a function of air temperature, t , and relative humidity, h (Concawe, 1977).

A_2 = Shielding attenuation from man-made structures. Except where specified otherwise, A_2 has been set to zero for this study (see discussion below).

A_3 = Shielding attenuation from land contours, man-made or existing. Except where specified otherwise, A_3 has been set to zero for this study (see discussion below).

A_4 = Shielding attenuation from trees and other vegetative ground cover (see discussion below).

A_5 = Meteorological effects, can be positive or negative. A_5 has been set to zero for this study (see discussion below).

The barrier effects of land forms and buildings (A_3 and A_2 , respectively, in the above equation) were not included in the noise contour figures presented in Chapter 3.1.3.1, or in either of the modeling sequences. To conservatively estimate impact and offset any short-term effects that weather conditions may present, no attenuation from these sources was assumed.

Many studies have been done on attenuation in forested areas. However, work by Harrison (1975) for the USDA indicates that maximum acoustic attenuation provided by trees and rocks, occurs in the first 150 m (500 feet).

The resulting octave band attenuation ranged from 14 dB at 250 Hz to 9 dB at 1,000 Hz and 0 dB above 1,000 Hz. Overall attenuation levels reported by Harrison (1975) for foliage and ground cover were 14 dB for conifers and hardwoods at distances greater than 110 m (350 feet). Also, the Federal Highway Administration (Barry, 1978) allows 10 dBA reduction if dense woods are at least 60 m (200 feet) in width between the road source and the receiver.

To account for the effects of the forest surrounding the mine/mill site, A_4 in the above equation has been conservatively set to 10 dB for distances of more than 150 m (492 feet) from the site. No adjustment was allowed for shorter distances even though attenuation would have an effect. The analysis assumes a conservative approach since no sensitive receptors are located within the 150 m distance.

It is acknowledged that during short periods of time, meteorological conditions (A_5 in above equation) could have a greater or lesser effect on the projected noise levels. The magnitude of this temporary change may be as high as 10-20 dBA.

The computer noise model developed by Exxon Research and Engineering Company (Rice, 1980), uses a derivation of the equation on Page A-5. The equation is presented below:

$$L_{eq}(f) = L_w(f) - 10\log 2\pi r^2 - 10\log UF - A_t(f)$$

where:

$L_{eq}(f)$ = The equivalent sound pressure level at frequency (f), dB.

$L_w(f)$ = The source sound power level at frequency (f), dB.

r = Distance between the source and receiver, in meters.

UF = Usage Factor for the source (percentage of time equipment operates in its noisiest mode).

$A_t(f)$ = The sum of attenuation factors, A_1 to A_5 , discussed previously.

The model is implemented for multiple noise sources by logarithmically summing the sound power level spectrum from all sources at the receiver location. After the sound pressure level spectrum at each receiver location have been computed, they are A-weighted and summed to yield the total A-weighted sound pressure level at the receiver location. The contour plots included in Chapter 3.1.3.1 were generated by repeating the above process over a grid of receiver locations. Table A-1 lists the source sound power levels used to generate the contour plots.

Traffic - The computations presented in Tables A-2 through A-5 were completed using an assumption of a uniform traffic flow over the course of a day. Although this assumption is simplistic, it does accurately calculate the change in daily L_{eq} caused by increased traffic flow. The L_{eq} energy change is only a function of the change in total vehicles per day. Any other comparison would provide a similar answer.

Blasting - Estimated noise levels generated from a confined shaft blast at different depths (plus 50 feet from the shaft collar) are presented below based on the following equation (Dupont 1977):

$$P = 82 \frac{R}{W^{0.33}}^{-1.2}$$

$$SD = \frac{R}{W^{0.33}}$$

where:

P = psi (overpressure)

R = feet (distance)

W = pounds (explosives) per delay

SD = feet (scaled distance)

Example calculations:

a. For start of main shaft blasting at 110 feet depth:

$$P = 82 \frac{110 + 50}{32^{0.33}}^{-1.2} = 0.73 \text{ psi}$$

TABLE A-1

NOISE SOURCES DURING CONSTRUCTION AND OPERATION
SOUND POWER LEVEL SPECTRUM (dB)

Equipment/Operations	UF	Octave Band Center Frequencies (Hz)							
		63	125	250	500	1K	2K	4K	8K
Mine Waste Disposal Facility Area									
Scraper Cat 631	.13	110	109	108	107	106	100	94	89
Dozer Cat D9	.15	112	110	109	108	107	102	96	91
Dozer Cat D8	.15	112	111	110	109	108	102	96	91
Dozer Cat D6	.15	111	110	109	108	107	101	95	90
Front End Loader Cat 988	.30	113	112	111	110	109	103	97	91
Front End Loader Cat 966	.30	115	114	113	112	111	105	99	95
Motor Grader Cat 16G	.30	112	111	110	109	108	102	96	91
Motor Grader Cat 14G	.30	106	105	104	103	102	96	90	85
Excavator Cat 235	.70	113	112	111	110	109	103	97	92
Backhoe JD 410	.15	105	104	103	102	101	95	89	84
Dump Truck Ford LT-9000	.50	121	120	119	118	117	111	105	100
Belly Dump Truck and Trailer	.50	121	120	119	118	117	111	105	100
Tailings Transport and Water Discharge Pipeline Areas									
Dozer Cat D7	.15	111	110	109	108	107	101	95	90
Backhoe Cat 235	.15	106	105	104	103	102	96	90	85
Front End Loader Cat 9888	.15	109	108	107	106	105	99	93	88
Dump Truck 5 CYD	.10	114	113	112	111	110	104	98	93
Flatbed Truck 8T	.10	105	104	103	102	101	95	89	84
Trencher	.70	115	114	113	112	111	105	99	94

TABLE A-1 (Continued)

Equipment/Operations	UF	Octave Band Center Frequencies (Hz)							
		63	125	250	500	1K	2K	4K	8K
Railroad Spur Area									
Chainsaw	.20	123	122	121	120	119	113	107	102
Front End Loader Cat 9888	.15	109	108	107	106	105	99	93	88
Front End Loader Cat 9920	.15	109	108	107	106	105	99	93	88
Dozer Cat D9	.15	112	111	110	109	108	102	96	91
Dozer Cat D6	.15	114	113	112	111	110	104	98	93
Backhoe (Comb)	.10	108	107	106	105	104	98	92	87
Motor Grader 16G	.10	108	107	106	105	104	98	92	87
Dump Truck 5 CYD	.10	123	122	121	120	119	113	107	102
Compactor	.10	108	107	106	105	104	98	92	87
Access Road and Haul Road Areas									
Chainsaw	.20	123	122	121	120	119	113	107	102
Front End Loader Cat 9888	.15	109	108	107	106	105	99	93	88
Front End Loader Cat 977L	.15	112	111	110	109	108	102	96	91
Motor Grader 16G	.10	111	110	109	108	107	101	95	90
Gradall G1200	.10	108	107	106	105	104	98	92	87
Dozer Cat D9	.15	112	111	110	109	108	102	96	91
Dozer Cat D6	.15	114	113	112	111	110	104	98	93
Backhoe (Comb)	.10	108	107	106	105	104	98	92	87
Dump Truck 5 CYD	.10	125	124	123	122	121	115	109	104
Compactor	.10	109	108	107	106	105	99	93	88
Crane	.05	107	106	105	104	103	97	91	86

TABLE A-1 (Continued)

Equipment/Operations	UF	Octave Band Center Frequencies (Hz)							
		63	125	250	500	1K	2K	4K	8K
		<u>Mine/Mill Area</u>							
1)	--	121	120	119	118	117	111	105	100
2)	—	117	116	115	114	113	107	103	98
		<u>Water Discharge Structure Area</u>							
—	—	115	114	113	112	111	105	99	94
		<u>Mine/Mill Site Operations</u>							
Train/Concentrator	—	111	130	119	124	120	117	110	104
Transformer	—	—	93	96	100	100	97	90	—
Crusher	—	116	98	85	73	66	62	58	55
Batch Plant	—	—	88	91	95	95	92	85	—
Air Heaters (2 units)	—	113	109	105	100	95	90	89	89
Compressor	—	104	104	84	77	77	74	69	69
Generator	—	—	105	104	105	105	102	94	88
Exhaust Raise Vent (4 units)	--	106	120	118	111	108	102	98	86
Mine Waste Disposal Facility	—	118	117	116	115	114	108	102	97
Access Road	—	81	83	86	80	77	73	65	56
Railroad Spur	--	104	123	112	114	113	110	103	97
Haul Road	—	122	121	120	119	118	112	106	101

1) Shaft located west of access road

2) Shaft located adjacent to timber and steel storage area

SOURCE: Pygin, 1982

TABLE A-2

SUMMARY OF DATA ON EXISTING AND EXPECTED TRAFFIC FLOW ON STATE HIGHWAY 55 NORTH AND SOUTH OF THE INTERSECTION WITH THE PROPOSED ACCESS ROAD^a

Vehicle/Location	VEHICLES/DAY Construction		VEHICLES/DAY Operation	
	Existing	Expected ^b	Existing	Expected ^b
Cars - North	846 ^c	1620	846 ^c	1096
Trucks - North	94 ^c	106	94 ^c	100
Buses - North	0 ^c	24	0 ^c	10
Cars - South	477 ^d	493	477 ^d	577
Trucks - South	53 ^d	65	53 ^d	59
Buses - South	0 ^d	8	0 ^d	4

^aSource: Existing traffic flow - RPC, Inc. 1983, Forecast of future conditions. RPC, Inc., Austin, Texas.

Expected traffic flow - EIR Sections 1.3 and 1.4.

^bExpected = existing + total (including round trip) increased traffic flow caused by Crandon Project.

^cBased upon total traffic flow of 940 vehicles/day.
90% assumed cars
10% assumed trucks

^dBased upon total traffic flow of 530 vehicles/day.
90% assumed cars
10% assumed trucks

TABLE A-3

FHWA HIGHWAY TRAFFIC NOISE PREDICTION MODEL

$$\begin{aligned}
 L_{eq}(h)_i &= (\overline{L}_0)E_i && \text{reference energy mean emission level} \\
 &+ 10 \log \left(\frac{N_i D_0}{S_i T} \right) && \text{traffic flow adjustment} \\
 &+ 10 \log \left(\frac{D_0}{D} \right)^{1+\alpha} && \text{distance adjustment} \\
 &+ 10 \log \left(\frac{\psi_a(\phi_1, \phi_2)}{\pi} \right) && \text{finite roadway adjustment} \\
 &+ A_s && \text{shielding adjustment}
 \end{aligned}$$

where

- $L_{eq}(h)_i$ is the hourly equivalent sound level of the i th class of vehicles.
- $(\overline{L}_0)E_i$ is the reference energy mean emission level of the i th class of vehicles.
- N_i is the number of vehicles in the i th class passing a specified point during some specified time period (1 hour).
- D is the perpendicular distance, in meters, from the centerline of the traffic lane to the observer.
- D_0 is the reference distance at which the emission levels are measured. In the FHWA model, D_0 is 15 meters. D_0 is a special case of D .
- S_i is the average speed of the i th class of vehicles and is measured in kilometers per hour (km/h).
- T is the time period over which the equivalent sound level is computed (1 hour).
- α is a site parameter whose values depend upon site conditions.
- ψ is a symbol representing a function used for segment adjustments, i.e., an adjustment for finite length roadways.
- A_s is the attenuation, in dB, provided by some type of shielding such as barriers, rows of houses, densely wooded areas, etc.

TABLE A-3 (continued)

Notes:

1. The speed limit on State Highway 55 where the model is being applied is 88 km/h (55 miles per hour). At that speed

$$(\overline{L}_0)_{\text{E-cars}} = 72 \text{ dBA}$$

$$(\overline{L}_0)_{\text{E-Buses}} = 82 \text{ dBA}$$

$$(\overline{L}_0)_{\text{E-Trucks}} = 86 \text{ dBA}$$

2. For one hour, the traffic flow adjustment term = $10 \log \left(\frac{N_i D_0}{S_i} \right) - 25$ where the units are defined as above.
3. The distance, finite roadway, and shielding adjustments = 0.
($D_0 = 15 \text{ m}$).

TABLE A-4

NOISE CALCULATIONS FOR TRAFFIC ON STATE HIGHWAY 55 NORTH
AND SOUTH OF THE INTERSECTION
WITH THE PROPOSED ACCESS ROAD DURING PROJECT CONSTRUCTION

North of site (Existing)		<u>L_{eq}, dBA @ 15 m</u>
Cars:	$L_{eq} (1 \text{ hr}) = 72 + 10 \log \left[\frac{\left(\frac{846}{24} \right) \times 15}{88} \right] - 25$	= 54.8
Trucks:	$L_{eq} (1 \text{ hr}) = 86 + 10 \log \left[\frac{\left(\frac{94}{24} \right) \times 15}{88} \right] - 25$	= 59.2
$L_{eq} (1 \text{ hr})$ total from above at 15 m from centerline of traffic lane		= 60.6
North of site (Expected)		
Cars:	$L_{eq} (1 \text{ hr}) = 72 + 10 \log \left[\frac{\left(\frac{1620}{24} \right) \times 15}{88} \right] - 25$	= 57.6
Trucks:	$L_{eq} (1 \text{ hr}) = 86 + 10 \log \left[\frac{\left(\frac{106}{24} \right) \times 15}{88} \right] - 25$	= 59.8
Buses:	$L_{eq} (1 \text{ hr}) = 82 + 10 \log \left[\frac{\left(\frac{24}{24} \right) \times 15}{88} \right] - 25$	= 49.3
$L_{eq} (1 \text{ hr})$ total from expected traffic at 15 m from centerline of traffic lane		= 62.1
L_{eq} increase = 1.5 dBA		

TABLE A-4 (continued)

South of Site (Existing)		<u>L_{eq} dBA @ 15 m</u>
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{477}{24}) \times 15}{88} \right] - 25$		= 52.3
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{53}{24}) \times 15}{88} \right] - 25$		= 56.8
L_{eq} total from above at 15 m from centerline of traffic lane		= 58.1
South of site (Expected)		
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{493}{24}) \times 15}{88} \right] - 25$		= 52.4
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{65}{24}) \times 15}{88} \right] - 25$		= 57.6
Buses: L_{eq} (1 hr) = $82 + 10 \log \left[\frac{(\frac{8}{24}) \times 15}{88} \right] - 25$		= 44.5
L_{eq} (1 hr) total from expected traffic at 15 m from centerline of traffic lane		= 58.9
L_{eq} increase = 0.8 dBA		

TABLE A-5

**NOISE CALCULATIONS FOR TRAFFIC ON STATE HIGHWAY 55 NORTH
AND SOUTH OF THE INTERSECTION
WITH THE PROPOSED ACCESS ROAD DURING PROJECT OPERATION**

North of site (Existing)		<u>L_{eq} dBA @ 15 m</u>
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{846}{24}) \times 15}{88} \right] - 25$		= 54.8
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{94}{24}) \times 15}{88} \right] - 25$		= 59.2
L_{eq} (1 hr) total from above at 15 m from centerline of traffic lane		= 60.6

North of site (Expected)		
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{1096}{24}) \times 15}{88} \right] - 25$		= 55.9
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{100}{24}) \times 15}{88} \right] - 25$		= 59.5
Buses: L_{eq} (1 hr) = $82 + 10 \log \left[\frac{(\frac{10}{24}) \times 15}{88} \right] - 25$		= 45.5
L_{eq} (1 hr) total from expected traffic at 15 m from centerline of traffic lane		= 61.2

L_{eq} increase = 0.6 dBA

TABLE A-5 (continued)

South of side (Existing)		<u>L_{eq} dBA @ 15 m</u>
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{477}{24}) \times 15}{88} \right] - 25$		= 52.3
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{53}{24}) \times 15}{88} \right] - 25$		= 56.8
L_{eq} (1 hr) total from above at 15 m from centerline of traffic lane		= 58.1
South of site (Expected)		
Cars: L_{eq} (1 hr) = $72 + 10 \log \left[\frac{(\frac{577}{24}) \times 15}{88} \right] - 25$		= 53.1
Trucks: L_{eq} (1 hr) = $86 + 10 \log \left[\frac{(\frac{59}{24}) \times 15}{88} \right] - 25$		= 57.2
Buses: L_{eq} (1 hr) = $82 + 10 \log \left[\frac{(\frac{4}{24}) \times 15}{88} \right] - 25$		= 41.5
L_{eq} (1 hr) total from expected traffic at 15 m from centerline of traffic lane		= 58.7
L_{eq} increase = 0.6 dBA		

$$SD = \frac{110 + 50}{32^{0.33}} = 51 \text{ feet}$$

from Figure A-1, SPL = 85; 75 dBA @ 20 Hz peak

- b. For middle of main shaft blasting at 1,425 feet depth:

$$P = 82 \frac{1,425 + 50}{32^{0.33}}^{-1.2} = 0.051 \text{ psi}$$

$$SD = \frac{2,745 + 50}{32^{0.33}} = 470 \text{ feet}$$

from Figure A-1, SPL = 61; 51 dBA @ 20 Hz peak

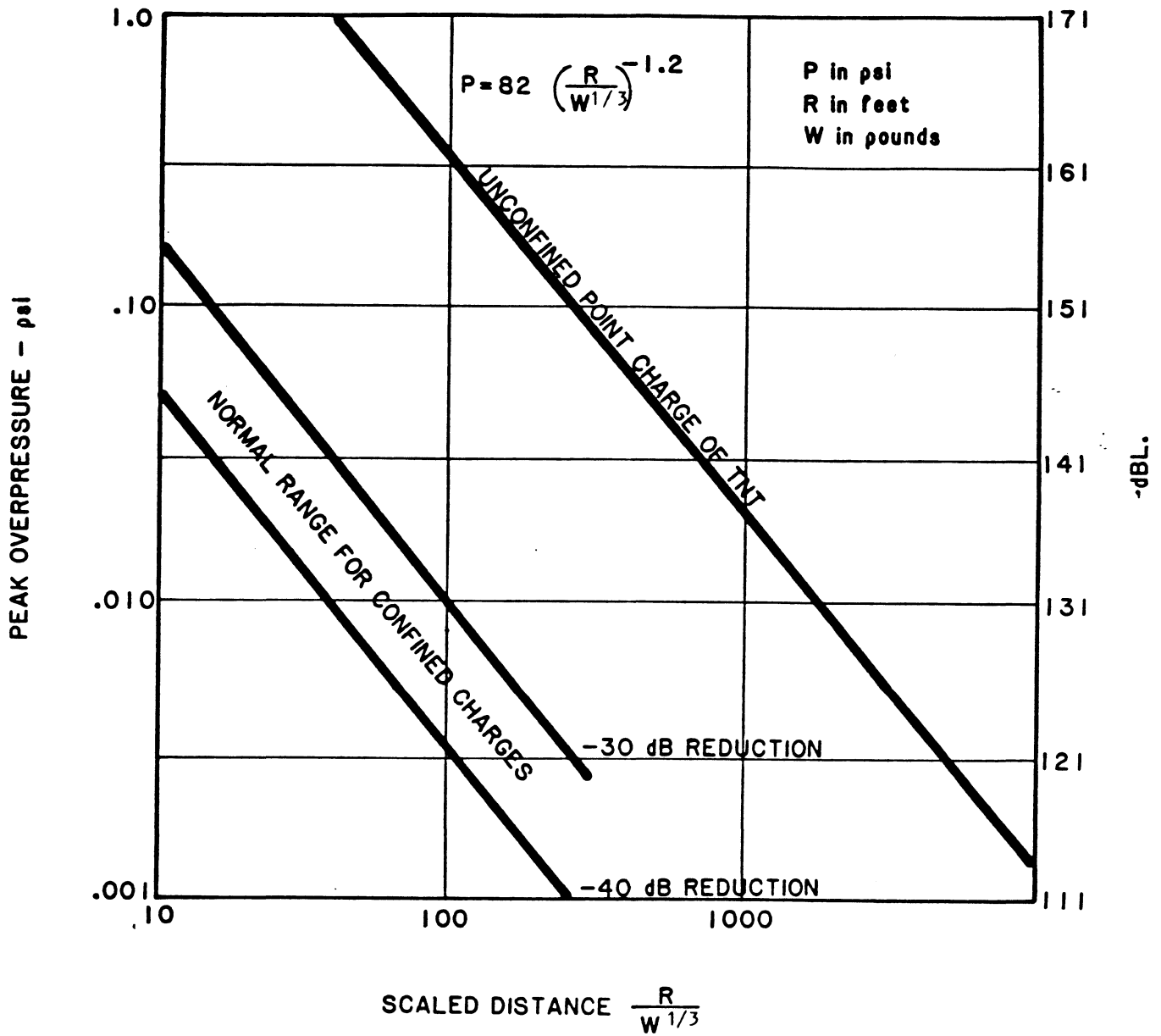
- c. For bottom of main shaft blasting at 2,745 feet depth:

$$P = 82 \frac{2,745 + 50}{32^{0.33}}^{-1.2} = 0.024 \text{ psi}$$

$$SD = \frac{2,745 + 50}{32^{0.33}} = 891 \text{ feet}$$

from Figure A-1, SPL = 57; 47 dBA @ 20 Hz peak

Figure A-1



Air blast overpressure as a function of distance and charge weight for the unconfined and confined charges. P is expressed in psi, R in feet, and W in pounds.

APPENDIX A
SEISMIC VIBRATION GLOSSARY

<u>Term</u>	<u>Definition</u>
Charge	An explosive, generally consisting of dynamite or other common explosive.
Delay	The primer or "starter" for an explosion can be fitted with a time delay, generally measured in milli-seconds to gradually permit the sequencing of blast "ignition". The resulting overall shock wave from a series of delayed charges is spread out through a longer period, resulting in less peak particle velocity at sites away from the work and generally a more efficient use of the explosives.
Peak Particle Velocity	The highest velocity that any particle at an observation site will reach, in any direction of movement, as a result of being affected by a shock wave from some source, such as an explosion. Common units are millimeters per second or inches per second.

APPENDIX A

REFERENCES

- American National Standards Institute, 1971a, American National Standard Specification for Sound Level Meters, SI.4-1971: ANSI, New York, New York.
- American National Standards Institute, 1971b, Acoustical Terminology, SI.1-1971: ANSI, New York, New York, p. 12.
- Barry, T., FHWA-RD-77-108, FHWA Highway Traffic Noise Prediction Model, U.S. Department of Transportation, Federal Highway Administration, (1978).
- Beranek, L.L., 1971, Noise and Vibration Control, Edited by L.L. Beranek: McGraw-Hill, Inc., New York.
- Bureau of Mines, 1980, Damage to Residential Structures from Surface Mine Blasting, SME-AIME Fall Meeting, October 22-24, 1980.
- Bureau of National Affairs, 1978, U.S. Environmental Protection Agency Acoustic Terminology Guide: Noise Regulation Reporter No. 111, Washington, D.C. (August 14).
- Concave, November 1977, "Noise Propagation from Petroleum and Petrochemical Complexes to Neighboring Communities - Phase 1," Report AT674.
- Dupont Company, Explosives Products Division, 1977, Blasters Handbook.
- Exxon Minerals Company, Revised Noise Impact Analysis Report, by Dames & Moore, p. 4.1-56, Transmitted to WDNR on March 8, 1984.
- Hanson, 1985, Exxon Minerals: Response to DNR Questions (January 4).
- Harrison, R., Impact of Off-Road Vehicle Noise on a National Forest. ED&T 2428 Noise Reduction of Forest Service Equipment, U.S. Department of Agriculture-Forest Service Equipment Development Center, San Dimas, California, July 1975.
- International Organization for Standards, 1971, Noise Assessment with Respect to Community Noise: Recommendation No. 1996.
- Jurewicz, R., 1984, 1984 Midwinter Bald Eagle Survey, Department of Natural Resources, Madison, Wisconsin.
- Kessler, F., 1978, Construction Site Noise Control Cost Benefit Estimation Technical Background: CERL Technical Report N-37.
- National Academy of Science, 1977, Guidelines for Preparing Environmental Impact Statements on Noise: Committee on Hearing, Bioacoustics, and Biomechanics, Washington, D.C.

- Peterson, A.P.G., and Gross, E.E., Jr., 1967, Handbook of Noise Measurement, 6th Edition: General Radio Company, West Concord, Massachusetts.
- Pygin, L., 1982, Project Manager, The Ralph Parsons Company: Letter to Exxon Minerals Company dated September 3, 1982.
- Rice, S.C., November 1980, "Revisions to Process Plant Noise Analysis Program, 3565 - Users Manual," Exxon Research and Engineering Company, Report EE.75E.80.
- Sadik, 1983, Exxon Minerals: Personal Communication to F. Kessler, Dames & Moore (August 24).
- Safeer, H.B., Wester, J.E., and Rickley, E.J., 1972, Errors Due to Sampling in Community Noise Level Distributions: Journal of Sound Vibration, Vol. 24, pp. 365-376.
- Sindelar, C., October 1, 1984, Wisconsin Bald Eagle Breeding Survey - 1984 General Report.
- U.S. Department of Labor, 1980, Noise Control: A Guide for Workers and Employers: U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C.
- U.S. Environmental Protection Agency, 1974, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety: U.S. EPA, Washington, D.C.
- U.S. Environmental Protection Agency, 1980, Effects of Noise on Wildlife and Other Animals-Review of Research Since 1971.